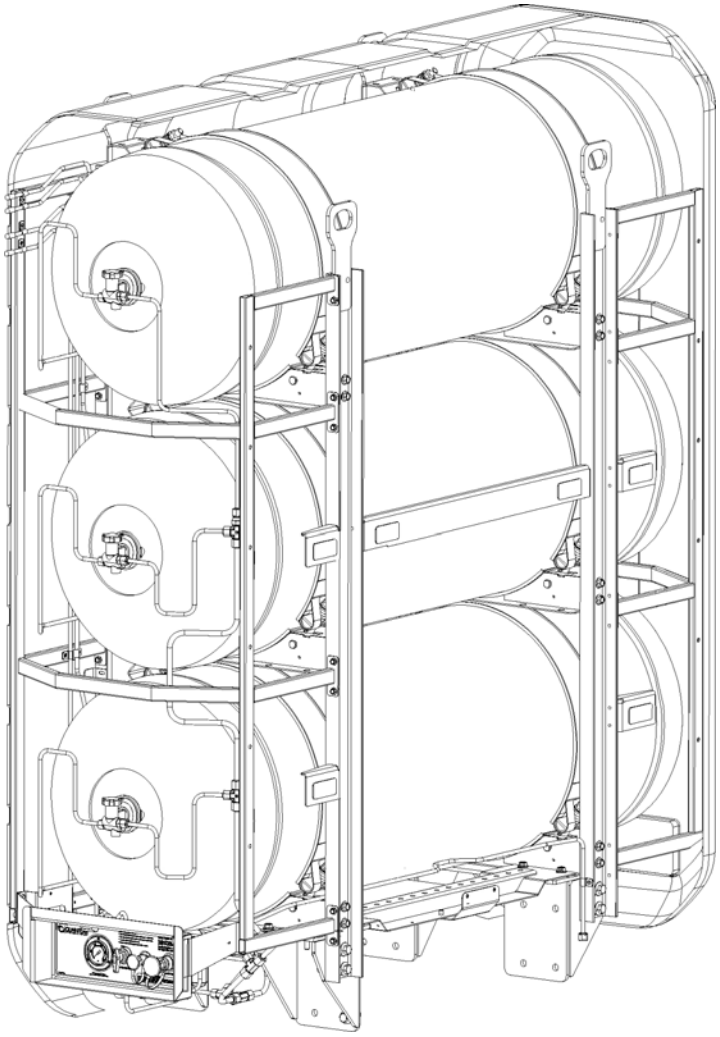
QUANTUM TECHNOLOGIES



CNG Gen 1 Back Of Cab FSM Installation Manual

Printed April 20, 2015

Rev A

Preface

This manual contains information and instructions required for the installation of the Quantum Fuel Systems Technologies Worldwide, Inc. CNG fuel storage and compression system. A thorough and complete understanding of the information and instructions contained in this manual is required for the installation and continued safe operation of the system. Read this manual from cover to cover and keep it for future reference.

The system must only be installed and serviced by trained and certified technicians who have read and understood this manual. Individual operator training is the responsibility of the company, firm, or organization placing the system in service. Reading this manual does not constitute certification.

This manual contains Cautions and Notices that must be observed at all times to reduce the risk of personal injury during operation or installation. Improper installation procedures may damage the system or make the system unsafe to operate. These Cautions and Notices are not all inclusive. Quantum Fuel Systems Technologies Worldwide, Inc. cannot possibly warn of all the potentially hazardous consequences caused by a failure to follow these instructions.

If you need further information or have any questions, please contact:
Quantum Fuel Systems Technologies Worldwide, Inc.
25242 Arctic Ocean Drive
Lake Forest, CA 92630
USA

Tel: 949.930.3400
Fax: 949.930.3401

All information, illustrations, and specifications are based on the latest product information available at the time of printing. Quantum Fuel Systems Technologies Worldwide, Inc. reserves the right to make changes at any time without notice.

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How to Use This Manual

This supplement contains information specific to the Back Of Cab (BOC) CNG fuel storage module (FSM). It does not explain everything you need to know about working with CNG equipment. You must use this installation manual along with the service manual for the other installed components. Only then will you be able to properly install and operate your equipment.

This manual contains information for the Gen 1 BOC CNG fuel storage module.

Ordering Parts

To purchase repair or replacement parts for the Gen 1 CNG Fuel Storage Module (115696 / 116353 / 116785) contact your local Quantum sales representative.

Technical Assistance

For questions regarding the installation, maintenance, and service for the Gen 1 CNG Fuel Storage Module contact Quantum Technical Assistance at 800.816.8691.

Price List

Published prices are accurate at the time of print and are subject to change without notice. For part pricing, contact your local Quantum sales representative.

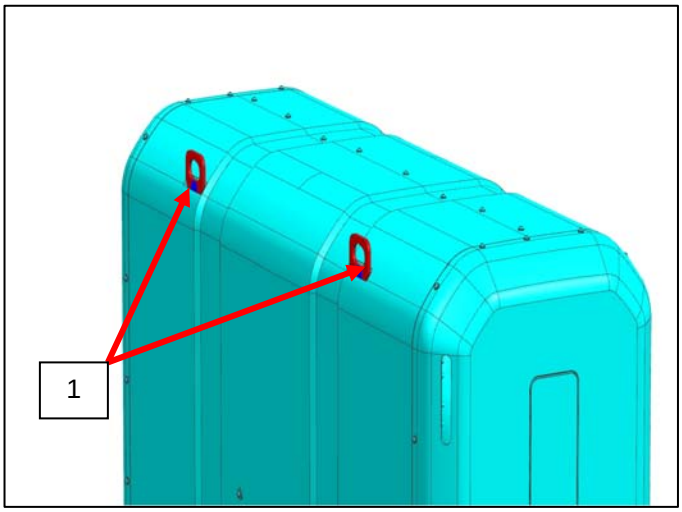
Module Identification

Generation 1

- 115696 – Fill Panel
- 116353 – Fill Panel
- 116785 – No Fill Panel (Slave)

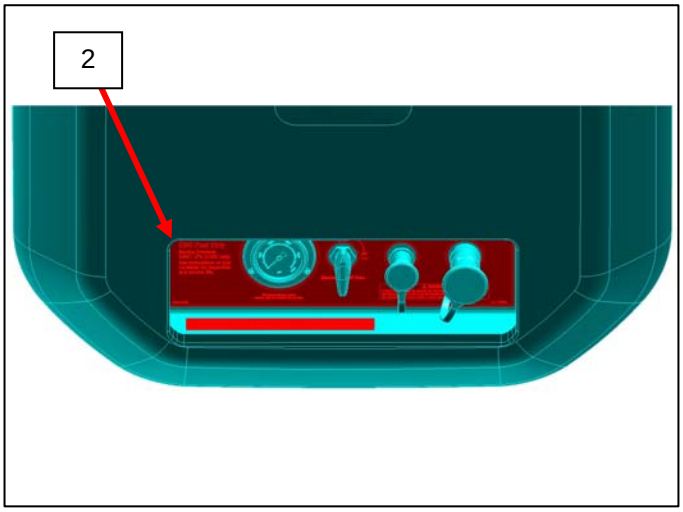
All of the generation 1 BOC FSMs will have two exposed lift hooks (1) located at the top front of the module.

There are two additional lift hooks located under the rear cover. The FSM has been designed with 4 lift points to safely lift and maneuver the module for service, maintenance, and / or inspection as needed.



Models with a fill panel (2) can be visually identified with a configuration as shown in the illustration to the right.

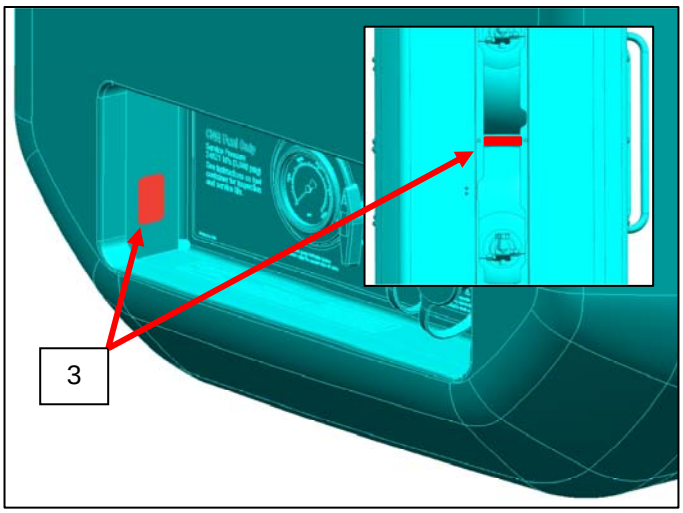
The slave model will not have any fill panel.



The part identification label (3) will be located in two separate locations depending on whether the FSM is equipped with a fill panel or if the FSM is a slave module.

If the FSM is equipped with a fill panel, then the part identification label is located on the inner left portion of the fill panel assembly.

If the FSM is a slave module, then the part identification label can be located inside the cylinder access panel on the frame.



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Introduction

The Back Of Cab (BOC) fuel storage module is designed to store Compressed Natural Gas (CNG). The FSM holds 3 cylinders which are contained within a vertical structure and protected with a lightweight, fiberglass housing. Each cylinder is configured with an individual PRD manifold assembly and thermal relief valves. The FSM features both standard fill and fast fill valves. The FSM covers are equipped with rear load lighting and a fill box light. The operating temperature for the fuel storage module has a range between -40°C to 85°C.

This manual provides information for the Gen 1 Back Of Cab model.

About Compressed Natural Gas

Natural gas is a by-product of oil drilling and coal mining, but it can also be harvested independently from natural gas fields. It can be used as a motor fuel in two forms, Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG).

Natural gas is lighter than air. If a leak were to develop, the gas would rise and disperse through the atmosphere giving little chance for ignition. Compare that to gasoline and diesel fuel, both of which are dense liquids that tend to pool and are easily ignitable. When CNG is burned in the engine, it produces low emissions. This means less smog, less air pollution and cleaner air. This makes CNG a promising motor fuel for the future.

Raw natural gas is odorless, so a distinctive odorant that smells very much like strong sulfur is added prior to distribution. This strong odor makes the presence of a leak very easy to detect. If an odor is detected, which has been added for your safety, please inspect the vehicle for the source of the concern and repair as needed.

Natural gas itself is a safer fuel than either gasoline or diesel fuel. It has a limited range of flammability, meaning it requires the correct mixture of air and fuel to burn—somewhere in the 5 to 15 percent range, and an ignition temperature of approximately 1100°F. Compare that to gasoline and diesel fuel which both have lower concentrations of flammability and lower temperatures of ignition.

Safety

Important Safety Information

This is the safety alert symbol. It is used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.

WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.

CAUTION indicates a hazardous situation which, if not avoided, could result in minor or moderate injury.

NOTICE is used to address practices not related to personal injury.

CAUTION, without the safety alert symbol, is used to address practices not related to personal injuries.

Read the safety precautions in this manual before servicing this system. Failure to do so could result in death or serious injury.

⚠ WARNING

CNG is extremely flammable. If something ignites it, you could be severely burned.

Keep sparks, flames and ignition sources a minimum of 5 meters from CNG.

Ensure work area is well ventilated.

Always wear proper eye and hearing protection when working with pressurized gas.

Use explosion proof drop lights when working on gaseous fueled systems.

Failure to follow these basic safety guidelines could result in serious death or personal injury.

⚠ CAUTION

CNG is stored at pressures up to 3,600 psi (25 MPa). Verify all pressure is properly vented from any fuel cylinder or fuel line before proceeding with disassembly. Failure to properly vent fuel system components could result in serious injury.

⚠ CAUTION

When filling your vehicle, keep sparks, flames and ignition sources a minimum of 5 meters from the refueling area which could result in minor or moderate injury including the risk for severe burns.

- **Do not smoke near CNG or while refueling a system.**
- **Turn the system's electrical system OFF while refueling.**
- **Refuel CNG fuel cylinders in a well-ventilated area.**
- **Keep mobile phones at a distance from the refueling area.**

⚠ CAUTION

Do not fill the fuel storage module with CNG if the cylinder pressure is less than 363 psi (2.5 MPa) AND the cylinder temperature is less than -31°F (-35°C).

Allow the fuel storage module temperature to rise above -31°F (-35°C) before filling.

Refueling under these conditions may cause personal injury and equipment or system damage. Failure to refuel under these conditions could result in minor or moderate injury.

⚠ CAUTION

Using a common automotive or plumbing O-ring as a replacement part could cause a leak while operating the system on CNG. Use only CNG certified O-rings from an authorized source. If something ignites the leak, you could be burned. Failure to use a certified O-ring could result in minor or moderate injury.

Safety Features

The CNG fuel system has been engineered to the highest standard to ensure occupant safety in any circumstance.

The system utilizes:

- Stainless steel fuel lines and fittings
- Type 4 (composite) fuel cylinders
- Over temperature protection
- Manual lock off valves
- Electronic lock off valve within the regulator assembly

In the Event of Equipment Fire

If a fire should occur in the vicinity of the cylinder system, the thermal relief devices located in the module may be activated. If any of the relief devices activates, a very rapid venting of gas may occur. If a fire caused the activation and the cylinder is full of a flammable gas, it is likely that the gas exiting the relief line will ignite which may be very dangerous. Even if the gas does not ignite, debris blown about by the gas jet could be dangerous and the loud noise caused by the rapid venting could cause hearing damage.

If the relief devices activates, then evacuate the area immediately and call the appropriate authorities. . Once any of the relief devices have been activated, the FSM or all of the cylinders must be returned to Quantum Technologies for inspection, disposition, and service.

System Overview

The Gen 1 BOC CNG fuel storage module was designed to be installed on the Class 7 and 8 heavy duty trucks with a maximum frame width as defined in the *General System Specifications* section of this manual.. The installation of this CNG fuel storage module may require minor adjustments or alterations of the vehicle to ensure a durable and safe installation.

This document outlines the procedure to install the Gen 1 BOC CNG fuel storage module on Class 7 and 8 heavy duty trucks.

The primary components of the CNG fuel storage module are:

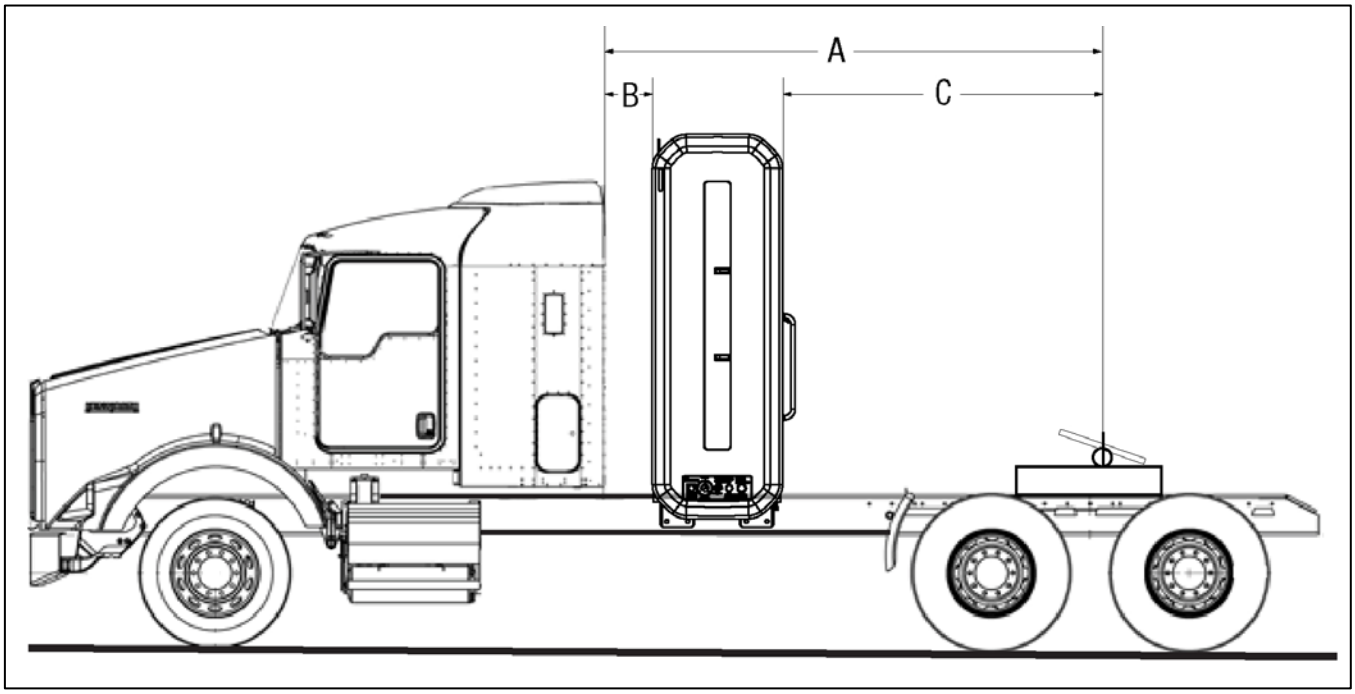
- CNG Fuel Storage Cylinders (Type 4)
- Manual Fuel Tank Shut-off Valves
- Standard CNG Fill Valve
- High Flow CNG Fill Valve
- High Pressure Regulator
- Fuel Gauge Module

System Design and Operation

The fuel storage module contains fuel storage cylinders, thermal relief devices, fiberglass housing, and Type 4 cylinder mounting brackets.

The CNG fuel storage cylinders used in this fuel storage module are Type 4 cylinders which are wrapped in carbon fiber. The cylinder is shipped empty and must be properly pressurized and purged prior to service. Refer to the *Start-Up Procedure* section of this manual for more information.

General Vehicle Requirements



DANGER

Inadequate distance between the FSM and trailer (trailer gap) may result in damage to the FSM. Always maintain adequate distance between the FSM and trailer (trailer gap) at all times. Failure to maintain adequate distance between the FSM and trailer may result in death or serious injury.

Dimensions

Minimum Distance Between Cab and Kingpin (A) ..... 106“ (2692mm)
Minimum Distance Between Cab and FSM (B) ..... 5“ (127mm)
Minimum Distance Between FSM and Kingpin (C)* ..... 70“ (1778mm)
* Verify measurement with the 5th wheel in the forward most position. Trailers with non-standard (42” or 48”) kingpins may require additional wheelbase and clearance.

Weight

FSM (Empty) ..... 1700 lbs (771 Kg)
FSM (Full) ..... 2500 lbs (1134 Kg)

Electrical Requirements

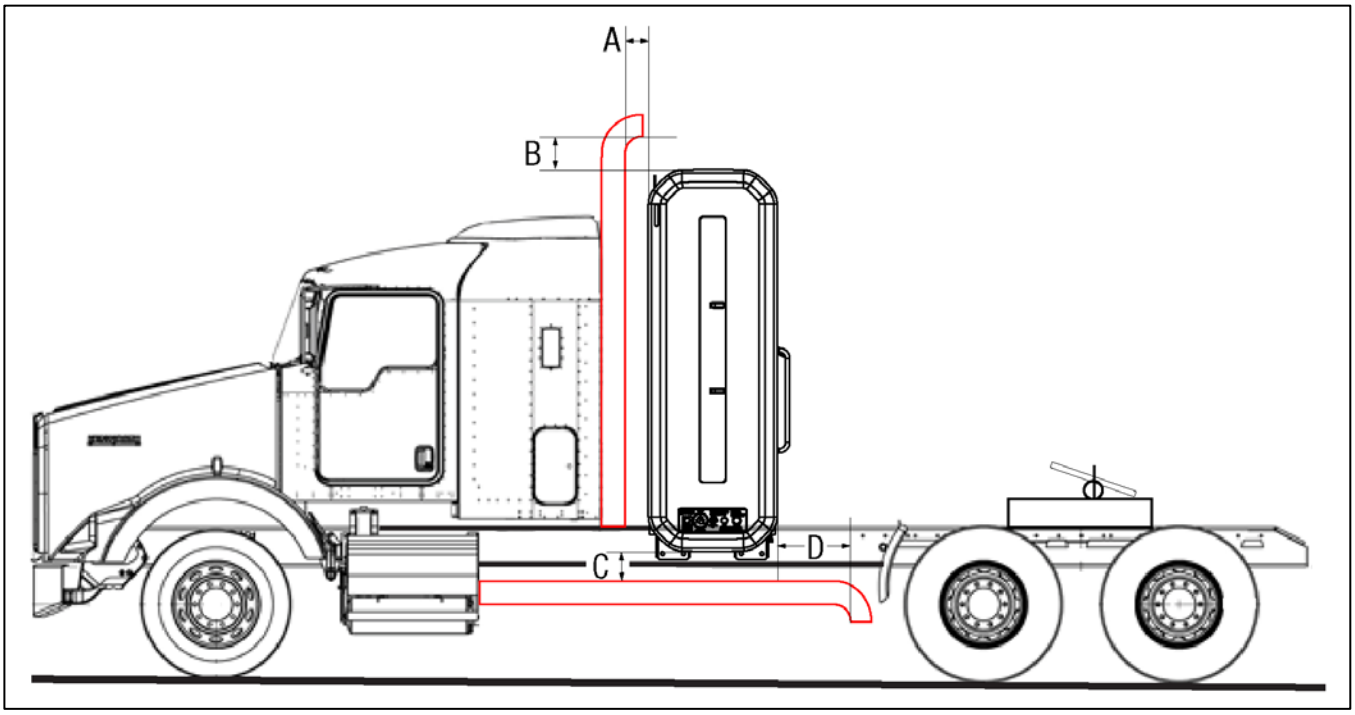
Voltage Range ..... 12-16 VDC
Nominal Current Draw ..... 2 A
Peak Current Draw ..... 3.5 A
BOC Electrical Connector ..... Deutsch HDP30-18-14 PN

Coolant

Minimum Coolant Flow ..... N/A GPM
Coolant Type ..... Glycol / Phosphate Based Coolant
Fitting Type / Connection ..... 5/8“ Hose Bib
Antifreeze Protection ..... <-40°F (-40°C)

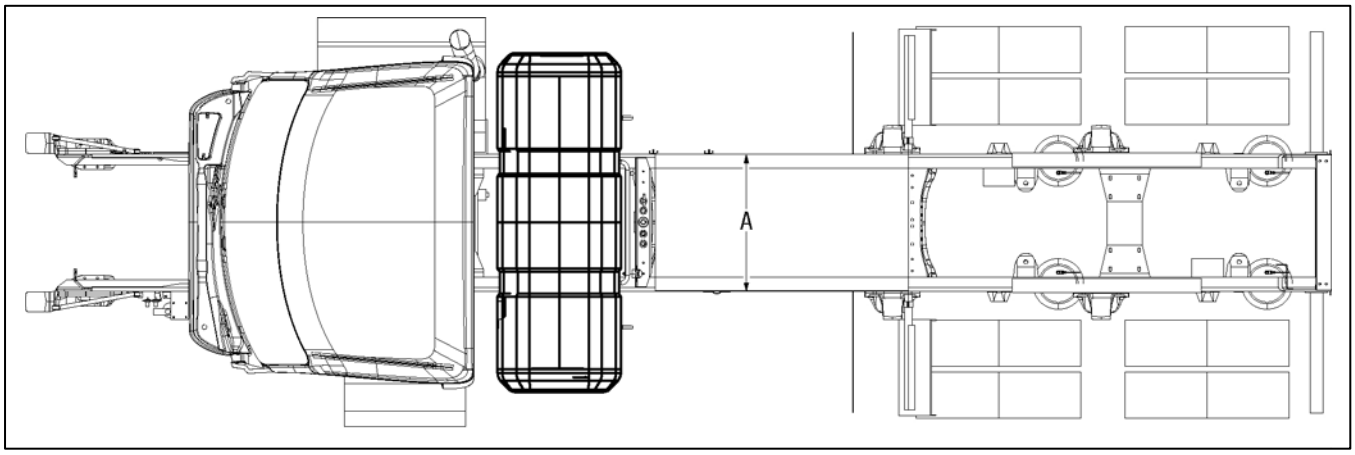
Fuel

Fuel Outlet Connection ..... -12 37° Flare, Stainless Steel



Exhaust

Minimum Distance Between Vertical Exhaust Stack and FSM (A) ..... 5“ (127mm)
Minimum Distance Between Vertical Exhaust Stack Outlet and FSM (B) ..... 5“ (127mm)
Minimum Distance Between Horizontal Exhaust Stack and FSM (C) ..... 8“ (203mm)
Minimum Distance Between Horizontal Exhaust Stack Outlet and FSM (D) ..... 12“ (305mm)

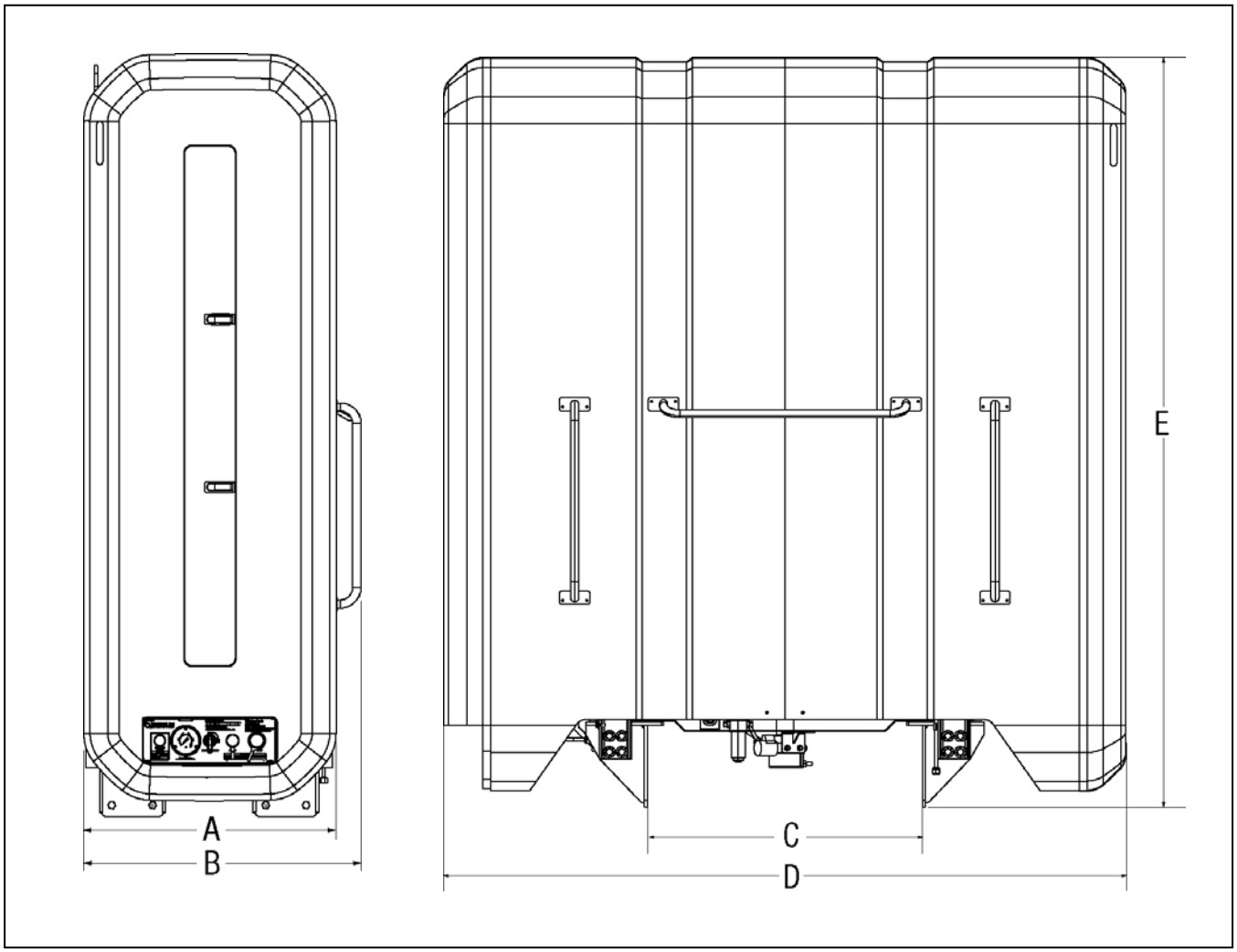


Dimensions

Maximum Distance Outside of Frame to Outside of Frame (A) ..... 34.5“ (876mm)
Minimum Allowable Width ..... 33.75“ (857mm)

General FSM Specifications

The Gen 1 BOC FSM has three different base mounts which will vary in width. These mounts are defined below and are identified with a -001, -003, and -005. You will need to confirm that the FSM width, which is identified by the part number, fits the frame of the truck.



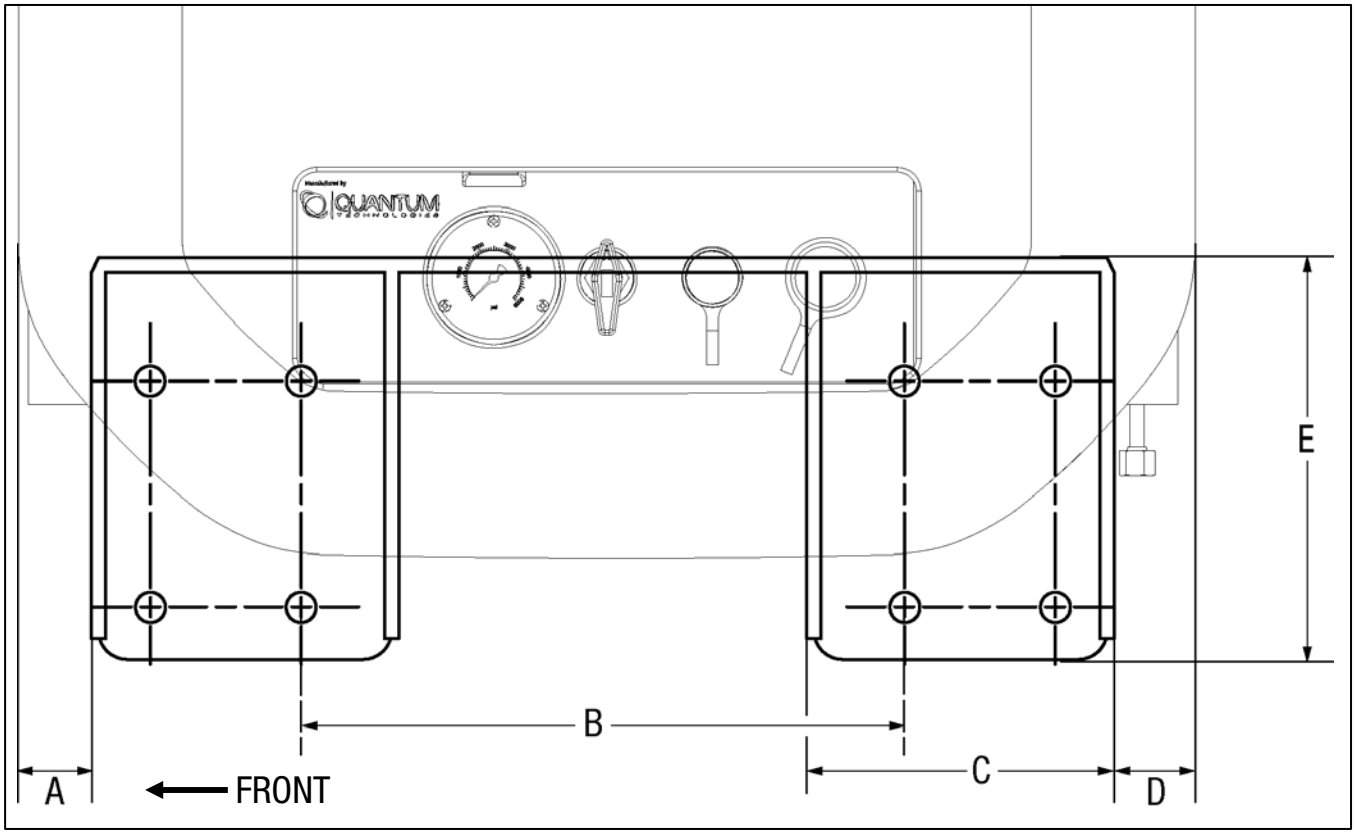
Dimensions

Depth of CNG Fuel Storage Module (A) ..... 30.7“ (780mm)
Depth of CNG Fuel Storage Module with Handles (B) ..... 33.8“ (859mm)
Maximum Width Between Mounts (C) ..... 34.5“ (876mm)
Width of CNG Fuel Storage Module (D) ..... 84.3“ (2142mm)
Height of the CNG Fuel Storage Module (E) ..... 93.0“ (2362mm)

Width (C) / Part Number*

Width Between Mounts PACCAR 116353-001 ..... 34.2“ (869mm)
Width Between Mounts Volvo / Mack 116353-003 ..... 33.8“ (859mm)
Width Between Mounts PACCAR (1/2“ Crossover) 116353-005 ..... 34.2“ (869mm)

* Refer to the *Label Locator* section in this manual for location information to the part number specific to the fuel storage module.



Dimensions

Distance Between FSM Mount and FSM Front Cover (A) ..... 2.0“ (51mm)
Distance Between Bolt Centerlines (B) ..... 15.7“ (400mm)
Width of Base Mount (C) ..... 8“ (204mm)
Distance Between FSM Mount and FSM Rear Cover (D) ..... 2.0“ (51mm)
Depth of FSM Mount (E) ..... 10.5“ (267mm)

Installer Qualifications

To successfully install the FSM, the installer should meet or exceed the minimum requirements indicated below:

1. Must have the ability to read, understand, and follow the instructions contained in the CNG Fuel Storage Module Installation manual.
2. Must have knowledge of all local, state, and federal regulations and standards applicable for installing CNG systems.
3. Must have a basic understanding of CNG fuel system installations.

Tool Requirements

In addition to standard technician tools and safety equipment, the following tools and supplies are required to install the fuel storage module:

Hand Tools

- Tape Measure
- 1/8” Hole Punch
- 3/8” Torque Wrench (lb/ft)
- 1/2” Torque Wrench (lb/ft)
- 5/8” Open End Wrench
- 11/16” Drill Bit with 1/2" Shank
- 11/16” Crowfoot
- 11/16” Angle Open End Wrench
- 13/16” Angle Open End Wrench
- 13/16” Crowfoot
- 18” Socket Extension

Shop Equipment / Tools

- Drill with 1/2” Chuck
- 9” Digital Caliper
- Inert Gas 6K Cylinder w/ Regulator, Lines, and CNG fill nozzle
- Lifting Straps or Chain (Rated to 3000 lbs+)
- Electronic Gas Detector
- Magnetic Base Drill Press (Recommended)
- Fork Lift (Recommend)
- Metal Base Mount Drill Template

Special Service Tools

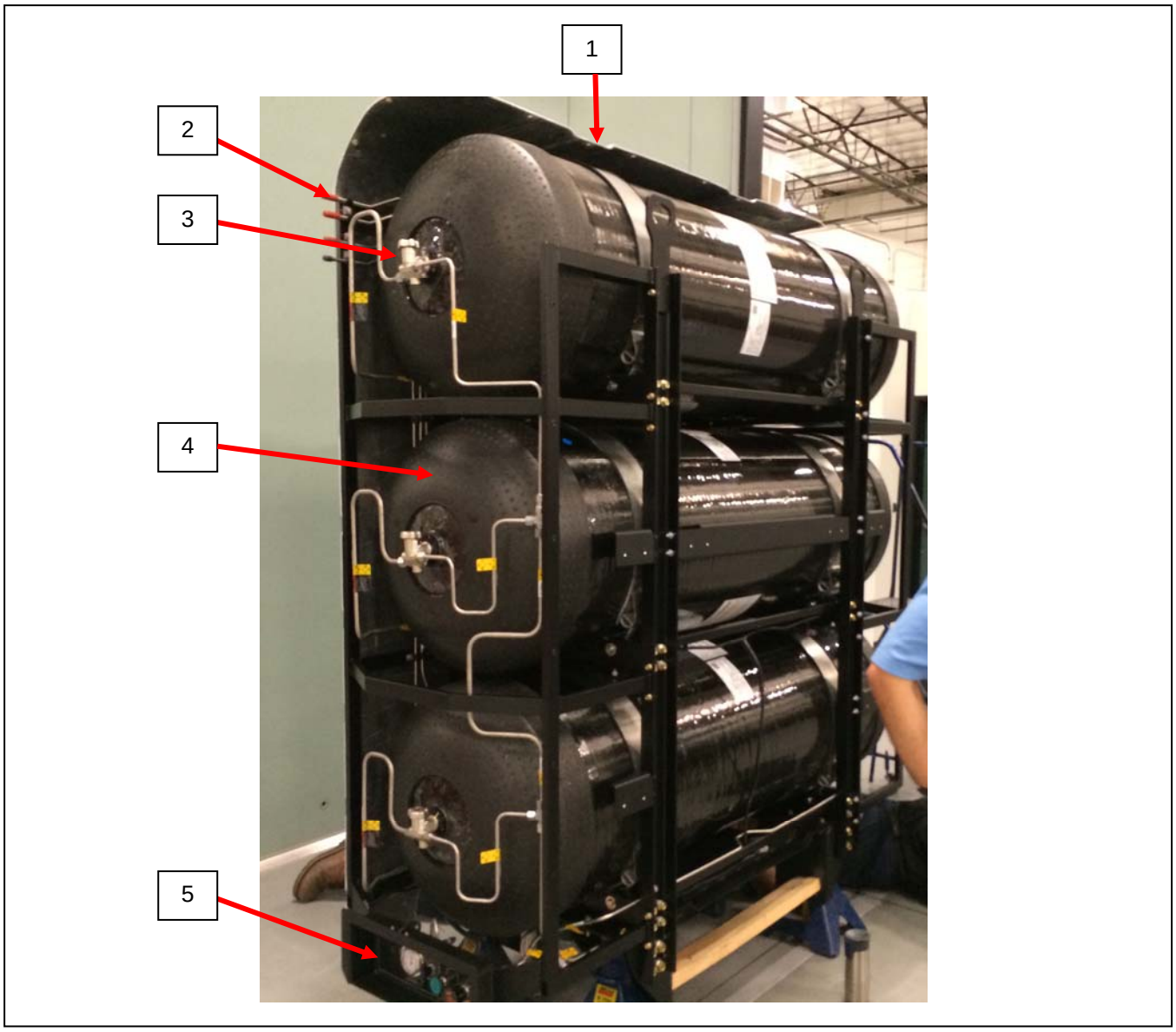
- Cylinder Installation Support Fixture

Fluid Requirements / Shop Supplies

- Snoop® Leak Detection Fluid
- Parker® O-Lube
- Zinc Rich Primer
- Fast Drying Enamel Paint
- 10w Oil

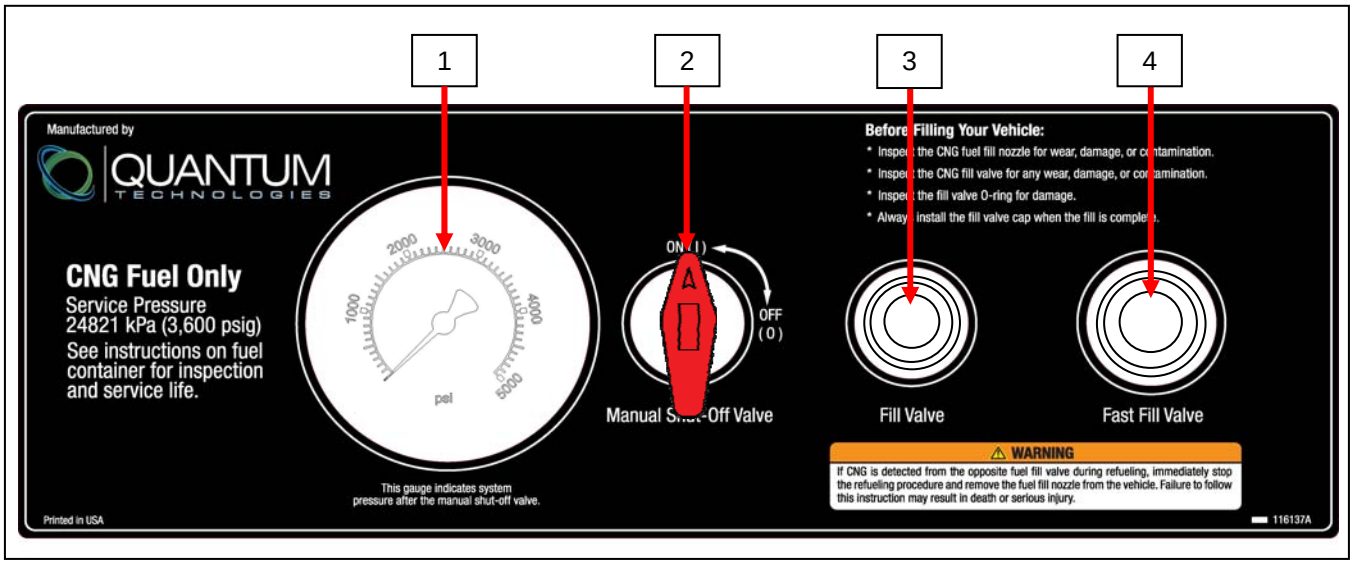
Components Locator

FSM System



1. FSM Front Cover
2. PRD Vent Lines
3. CNG Cylinder Valve (Qty 3)
4. CNG Cylinder (Qty 3)
5. Fill Panel

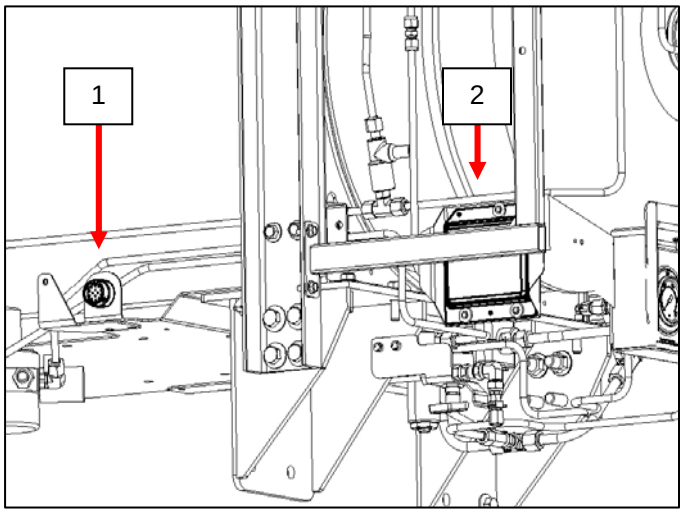
Fill Panel


1
2
3
4
Manufactured by
QUANTUM
TECHNOLOGIES
CNG Fuel Only
Service Pressure
24821 kPa (3,600 psig)
See instructions on fuel container for inspection and service life.
Before Filling Your Vehicle:
* Inspect the CNG fuel fill nozzle for wear, damage, or contamination.
* Inspect the CNG fill valve for any wear, damage, or contamination.
* Inspect the fill valve O-ring for damage.
* Always install the fill valve cap when the fill is complete.
ON (I)
OFF (O)
Manual Shut-Off Valve
Fill Valve
Fast Fill Valve
psi
This gauge indicates system pressure after the manual shut-off valve.
WARNING
If CNG is detected from the opposite fuel fill valve during refueling, immediately stop the refueling procedure and remove the fuel fill nozzle from the vehicle. Failure to follow this instruction may result in death or serious injury.
Printed in USA
116137A

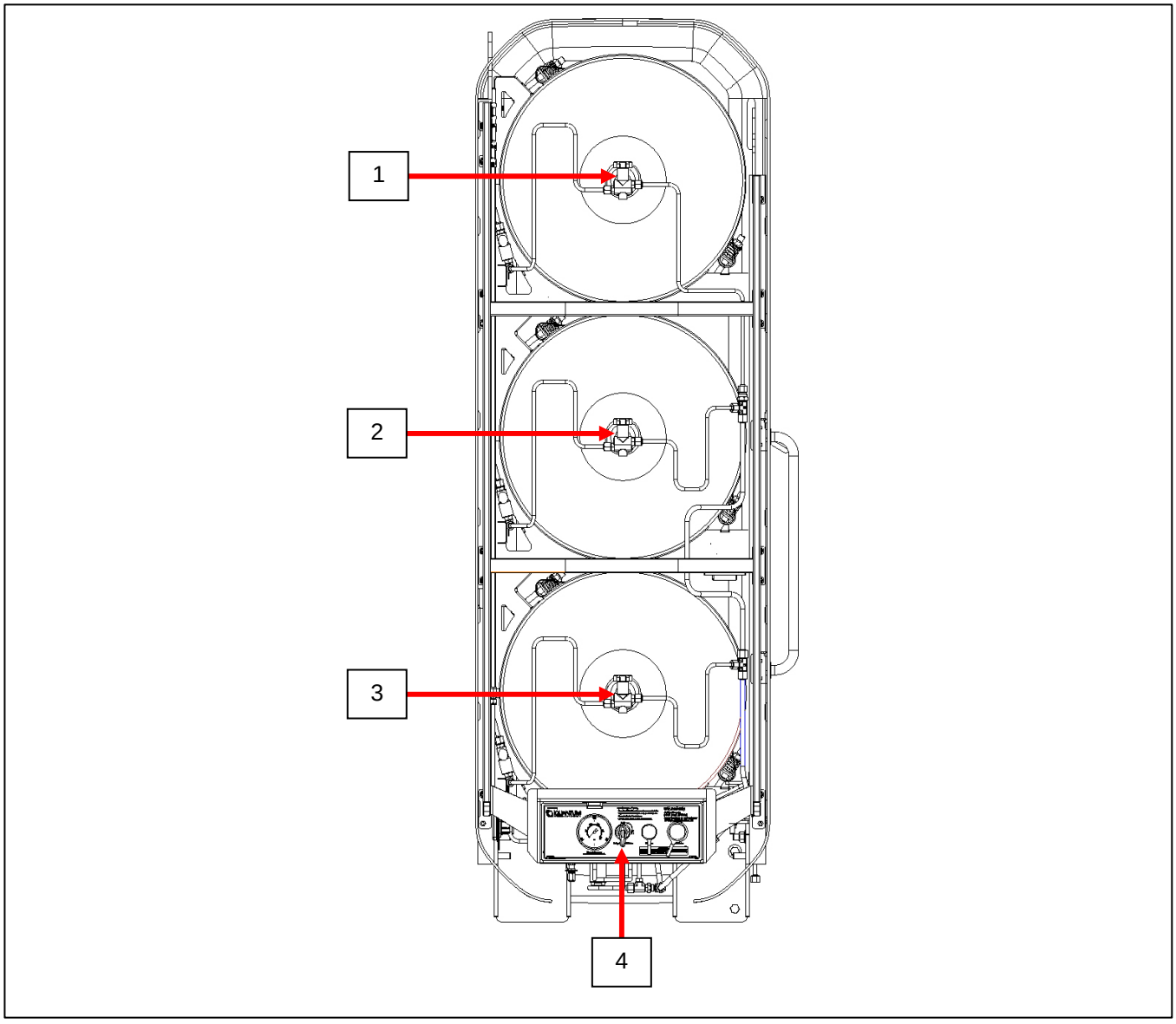
1. CNG Pressure Gauge
2. 1/4-Turn Manual Shut Off Valve
3. Standard NGV1 CNG Fill Valve
4. High Flow, ISO 14469-2, CNG Fill Valve

Fuel Gauge Module

1. Electrical Connector / Interface
2. Fuel Control Module

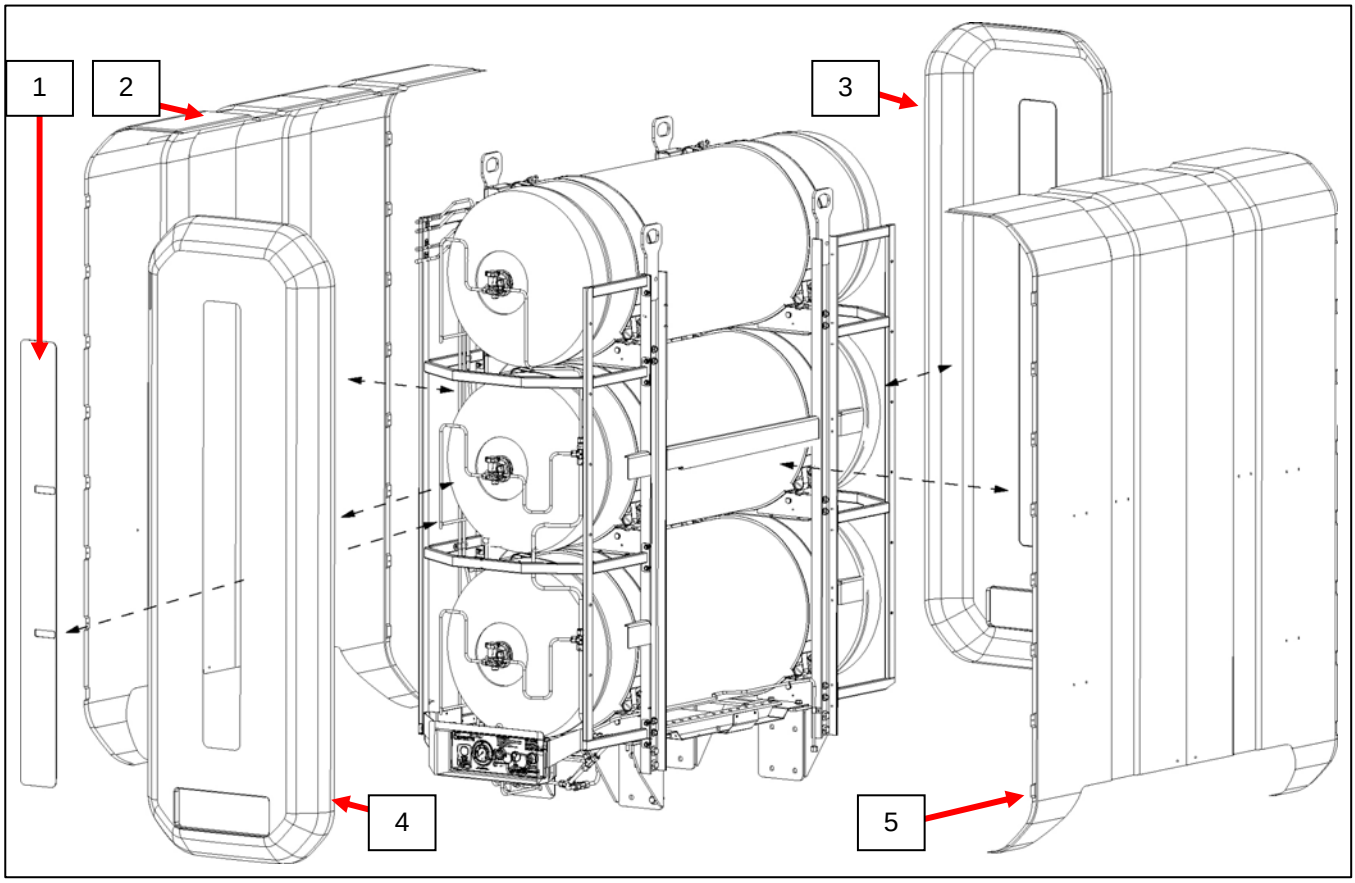


Safety Valves



1. CNG Fuel Storage Cylinder – Manual Valve (Top Cylinder)
2. CNG Fuel Storage Cylinder – Manual Valve (Middle Cylinder)
3. CNG Fuel Storage Cylinder – Manual Valve (Bottom Cylinder)
4. 1/4-Turn Manual Shut Off Valve

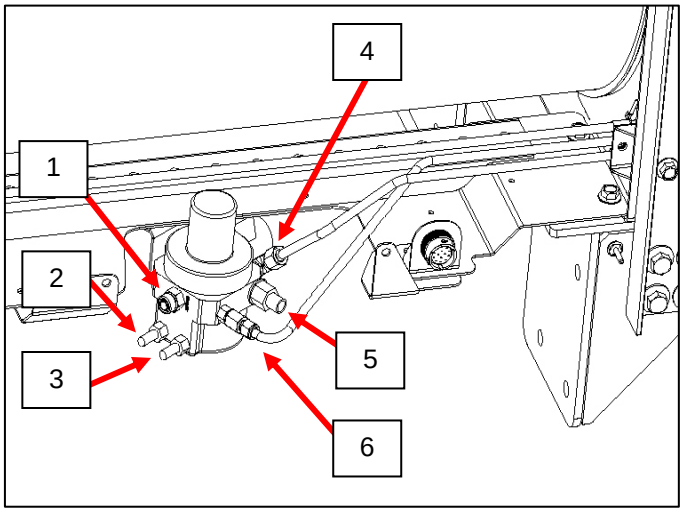
Covers



1. Access Door
2. Front Cover
3. Right-Side Cover
4. Left-Side Cover
5. Rear Cover

Line Identification

Lines from the fuel storage module bulkhead are located below the FSM next to the electrical interface connector.



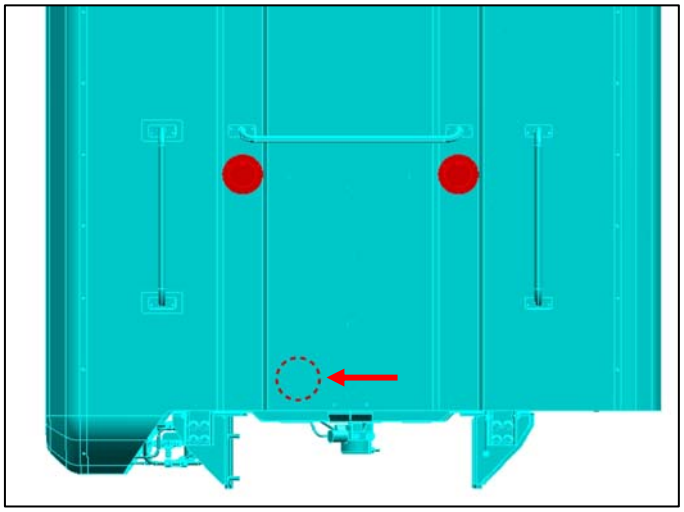
The lines are identified below:

1. CNG Outlet (Regulated) - 5/8” 37° Flare
2. Coolant In / Out – 5/8” Bib
3. Coolant In / Out – 5/8” Bib
4. CNG Inlet
5. CNG Pressure Sensor
6. PRD Vent

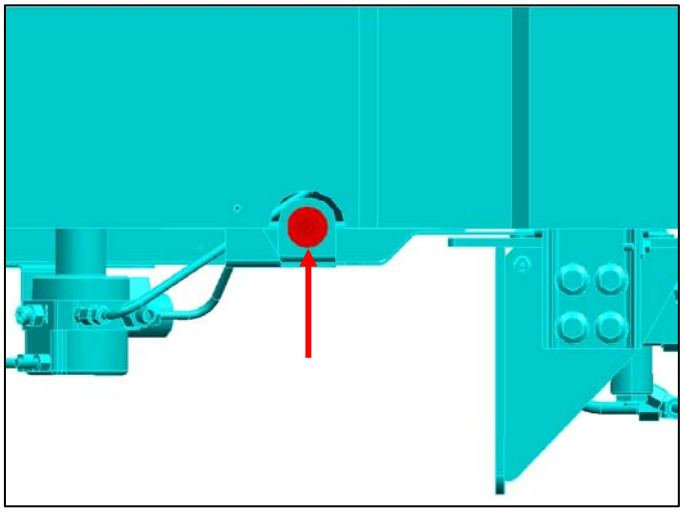
Always have protective caps covering the lines when they are not connected to the vehicle to prevent foreign matter from entering the system.

Load Light Connector

The load lights have a pigtail connector at the base of the cover to the left of center. The connector must be disconnected whenever the rear cover is removed from the BOC.



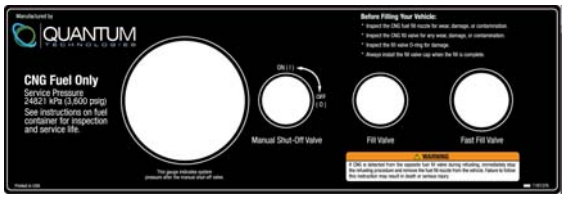
Power to the load lights is supplied through the main electrical interface located at the base of the front cover on the fuel storage module behind the fill panel.



Label Locator

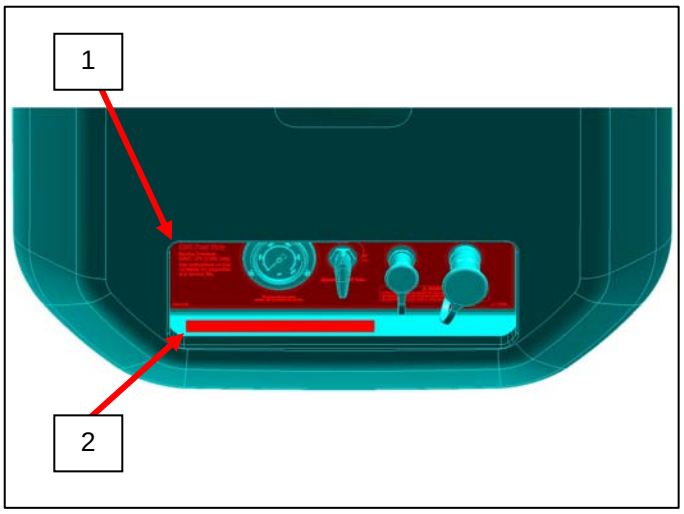
Always replace any damaged or missing labels.

1



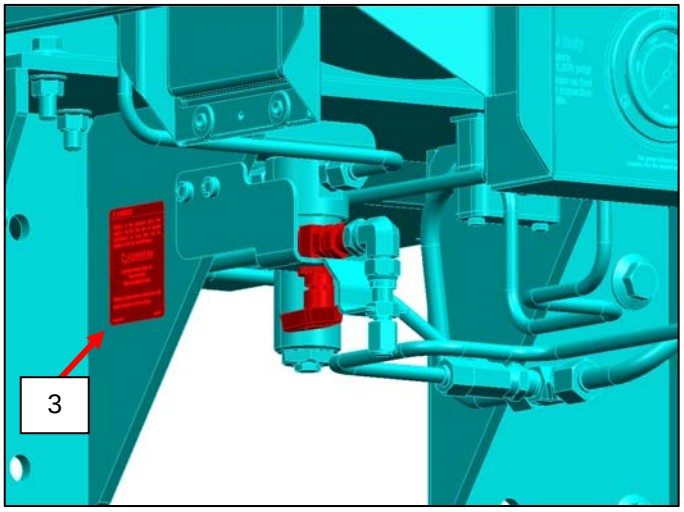
2

QUANTUM
TECHNOLOGIES
CNG Fueled Vehicle
Service Pressure 24821 kPa (3,600 psig)
Fuel container life expires
Fuel containers are to be inspected by the date indicated below and each 36 months thereafter



3

DANGER
Venting of the pressure from this system requires the use of special instructions or tools that can be obtained from the manufacturer.
QUANTUM
TECHNOLOGIES
Quantum Technologies Inc.
949·930·3400
QTService@qtww.com
Failure to follow these instructions will result in death or serious injury.
Printed in USA
114270 A



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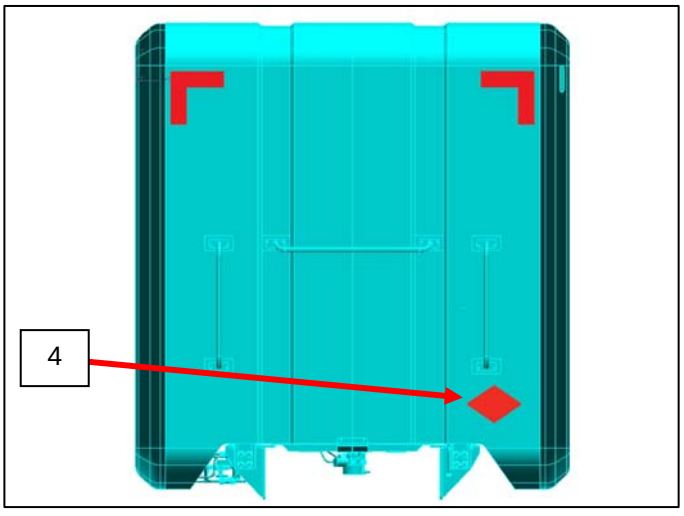

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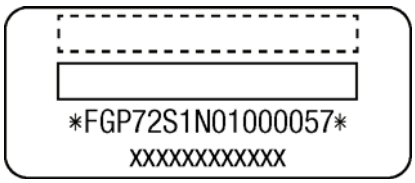

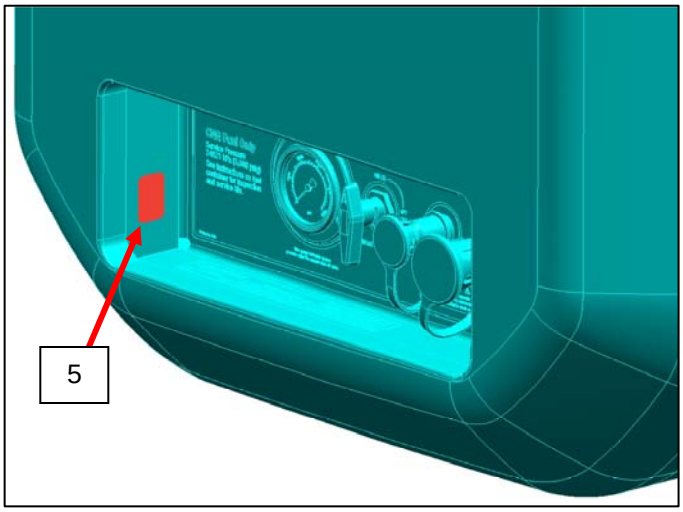

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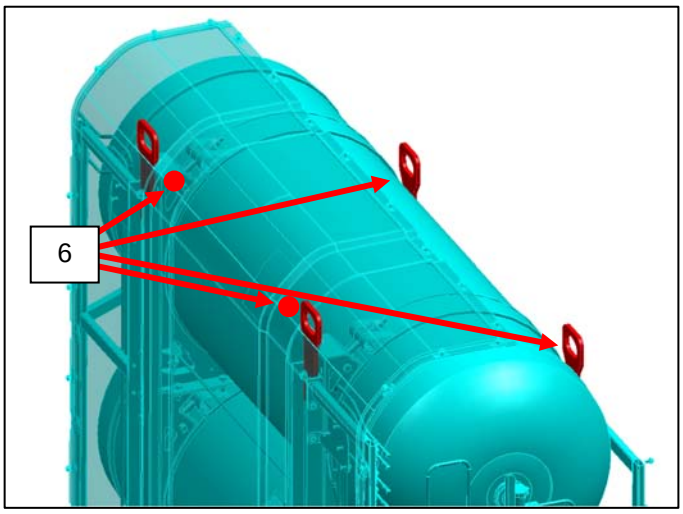


Packaging Contents and Assembly

The FSM will be shipped on a pallet and must be handled and stored vertically. The system will be fully assembled and will require disassembly of the rear cover and side covers before installation.

The contents of the delivery will include:

- 1 Fuel Storage Module (Gen 1 BOC)
- Frame Install Kit
  - 16 Screws, Hex Flange, M16
  - 16 Nuts, Crimp, Hex Flange, M16
  - 16 Washers, M16
  - 2 Shims, 1/16”
  - 2 Shims, 1/8”
- 2 Hose Clamps, Coolant
- 1 Interface Harness

Accessories

The FSM will have several optional accessories available:

Description	Part Number	Manual Reference
Stub Out Pipe Kit for Slave Module	116228	*Slave Cylinder Connection*
1/16” Shim (0.0625”, 1.6mm)	116161-001	*Shim Installation*
1/8” Shim (0.125”, 3.2mm)	116161-002	*Shim Installation*
10’ CNG Low Pressure Flex Hose	116574-003	-
12’ CNG Low Pressure Flex Hose	116574-004	-
18’ CNG Low Pressure Flex Hose	116574-006	-

Module Lifting

⚠ DANGER

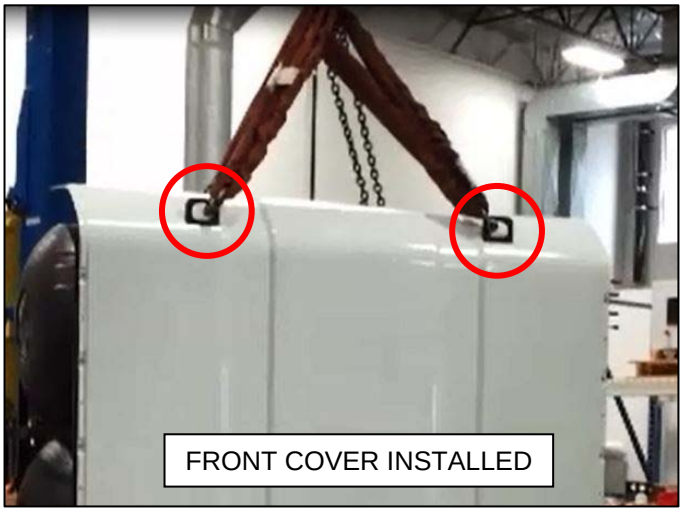
Lifing the FSM with a single strap is not recommended. Always use at least two straps that are rated and capable of holding the FSM. Failure to lift with two capable straps will result in death or serious injury.

The fuel storage module has four (4) lift points supplied, two under the cover and two that protrude through the cover. It is recommended that the FSM be lifted using all four supplied lift points to allow for proper handling and ease of installation. The FSM may be lifted by the two (2) exposed lift points only but the assembly will not hang properly and may be difficult to install. The chain or straps must exceed 3000 lbs (1361kg) lifting capacity.

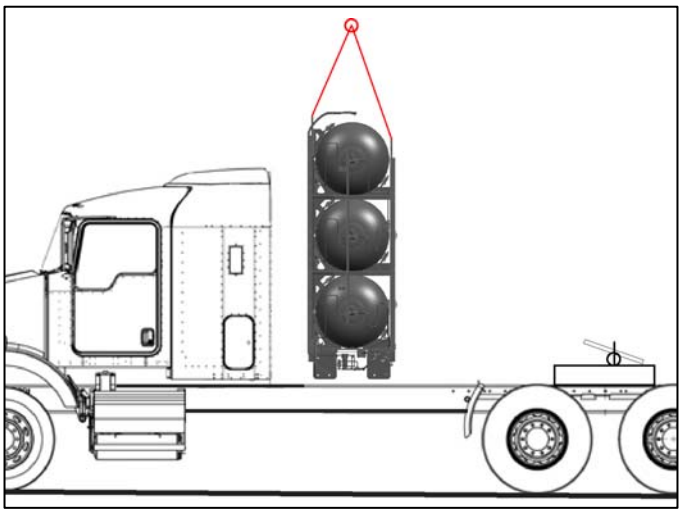
REAR COVER REMOVED

The FSM has a dry weight of 1700 lbs (771 Kg) and will require lifting equipment that can safely sustain that weight. The photo to the right shows a configuration that can safely lift the FSM. This is not the only option to lift the FSM, but it does permit the FSM to be maneuverable during the installation process.

The front cover must remain on the FSM during the installation process. The 2 lift points that protrude through the front cover are highlighted in the photo to the right. Use protective coverings so that the chain does not damage the Class A paint finish on the cover or the CNG cylinders.


FRONT COVER INSTALLED

The total ceiling clearance recommended to lift the FSM is 15 ft (4.6m). Be sure the shop has a lift and adequate ceiling clearance to install the FSM onto the frame of the truck. Lifting clearance will vary depending on truck frame height and the type of lifting fixture used.



Torque Specifications

Fuel Line

37° Flare (Stainless / Stainless) ..... 60 lb-ft. (81N.m)

Hex Flange

M6-1.0 (FSM Covers) ..... 62 lb-in. (70dN.m)
M8-1.25 (FSM Covers) ..... 62 lb-in. (70dN.m)
M12 ..... 63 lb-ft. (85N.m)
M12 w/ Stover Nut ..... 81 lb-ft. (110N.m)
M16 FSM to Frame (10w Lubricant Required) ..... 180 lb-ft. (244N.m)
Cylinder strap nuts ..... See **Note 1**

Note 1: The strap nut is tightened until the installed height of the spring on each end of the cylinder strap is 1.23" ±0.08" (31mm ± 2mm) with the cylinder pressure below 500 psi (34.5 bar). The straps for Gen 1 BOC are preset during assembly and are not adjustable.

Vehicle Compatibility

The Gen 1 BOC FSM is designed for Class 7 and 8 trucks with a maximum frame width of as defined in the *General System Specifications*. All clearances must be adhered to per the *General System Specifications* of this manual.

Always comply with federal, state, and local regulations when installing the FSM onto a vehicle.

Frame Preparation

This FSM has been designed as a generic fuel storage module for Class 7 and 8 trucks. Any application deviation may require modifications to the steps below. The installation instructions are intended to guide a knowledgeable and experienced CNG technician through the necessary steps to install the FSM.

Be sure to inspect the frame for prior damage, rust, welds, areas missing paint, and/or reinforcement plates. These indicators could mean that the frame's structural integrity may be compromised.

Compliance of the installation to all federal, state, and local regulations is ultimately the responsibility of the installer.

It is the responsibility of the installer to ensure the vehicle being equipped with the FSM is in good condition and that installation of this system will not create a hazard or cause damage to the vehicle.

> *IMPORTANT:* ***Before you begin the installation process of the fuel storage module, you should verify the installed assembly will meet all your customer requirements and regulatory requirements that may be applicable.***

There are a number of considerations when determining where to place the FSM on the vehicle frame:

- Will the width of the frame be within the mount specification range for the FSM?
- Are there any heat sources in close proximity to the FSM?
- Will there be enough clearance between the FSM and the trailer?
- Are there any cross members or support structures that would interfere with the FSM?
- Will any of the accessories interfere with the BOC installation?
- Will an auxiliary battery storage unit located under the FSM need to be relocated?

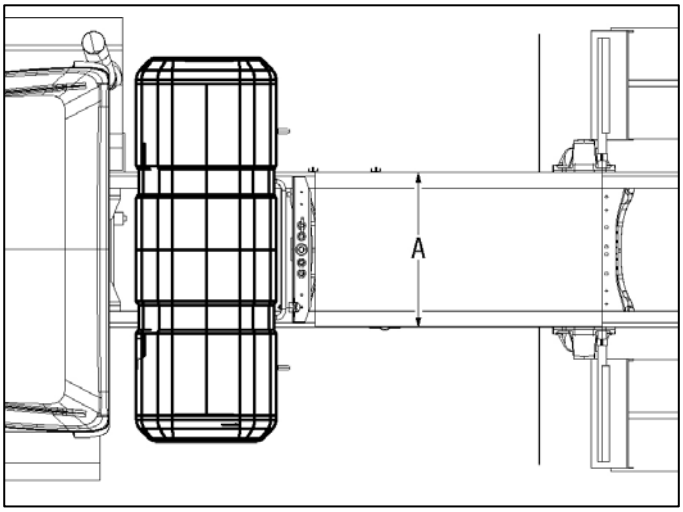
Below are a few steps that will help you determine if the FSM can be successfully installed and meet all the Quantum, regulatory, and customer requirements:

- Step 1 – Measure Frame Width
- Step 2 – Measure FSM Clearance
- Step 3 – Inspect for Obstructions
- Step 4 – Inspect for Heat Sources
- Step 5 – Installation Checklist
- Step 6 – Frame Drilling Guidelines

Step 1 Measure Frame Width

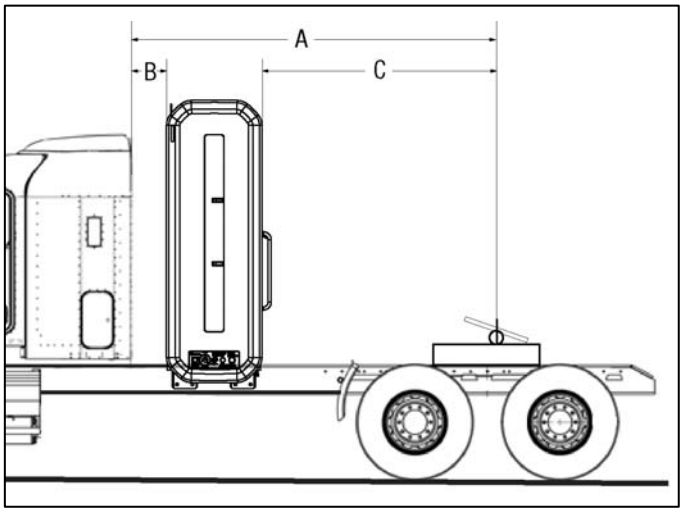
Verify the overall width of the fuel storage module will fit in the allocated space and the area where the FSM is to be installed is free of parts, brackets, bolts, or components that may contact or damage the FSM. Verify the width of the vehicle frame is large enough to accept the FSM with appropriate clearance.

The overall dimensions for the FSM are contained in this manual. Refer to *General System Specifications* in this manual for additional information.



Step 2 Measure FSM Clearance

Confirm that the space between the cab and the kingpin (A) meets the minimum requirement as specified in the *General Vehicle Requirements* section in this manual.



Verify the FSM will have adequate clearance from the rear wall of the driver's cab to the front of the FSM assembly (B) and the FSM to the kingpin (C).

The FSM must maintain a minimum distance of 5" (127mm) between the FSM and the rear wall of the driver's cab. The location where the FSM will be mounted must have this minimum clearance or damage to both the driver's cab and FSM may occur.

The installer must first determine distances A, B, and C and then fit the application to leave adequate clearance to the vehicle components for service and assembly.

> *IMPORTANT:* ***If the truck is equipped with an adjustable 5th wheel assembly, then place the assembly into the forward most position when making the following measurements.***

Measure 106" (2692mm) from the back of the driver's cab down the frame rail to the kingpin (A). This will determine if the truck has enough space to accommodate a FSM.

Then, measure 70" (1778mm) from the kingpin up the rail towards the FSM. This is the minimum clearance needed for the trailer with or without a reefer (C).

(B + C) – A = total allowable area for the FSM. Refer to the measurements in the *General Vehicle Requirements* section of this manual.

⚠ DANGER

> **Inadequate distance between the FSM and trailer may result in damage to the FSM. Always maintain adequate distance between the FSM and trailer at all times. Failure to maintain adequate distance between the FSM and trailer may result in death or serious injury.**

The remaining area to mount the FSM will become important if the FSM system must be positioned to avoid obstacles and heat sources mentioned in the upcoming chapters.

Before proceeding, the installer should consult all federal, state, and local regulations to ensure the installation will comply with all requirements.

Step 3 Inspect for Obstructions

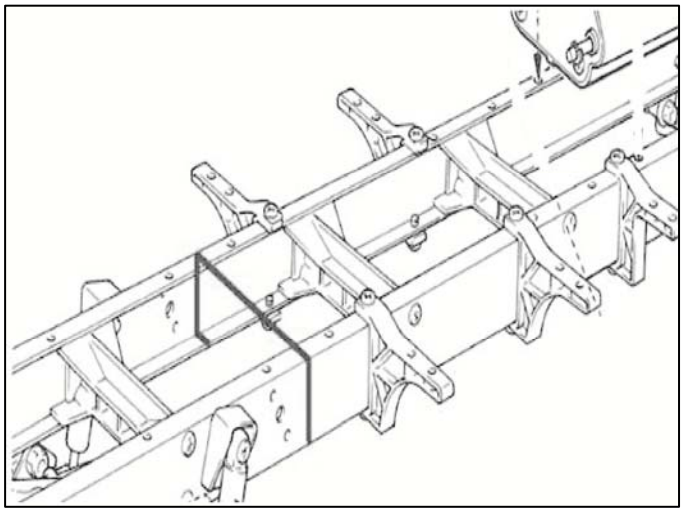
Verify the area of the vehicle where the FSM will be installed is clear of any obstructions or components that may contact or damage the FSM.

Check the area of the frame where the FSM will be mounted and note any obstructions or components that may contact the FSM. Relocate components as necessary per the manufacturer's instructions.

Also inspect for any brackets or features on the frame rail that may interfere with the FSM. This includes any additional inner and/or outer support rails that may have been added to the frame. Additional rail supports that have been added may affect the bolt length requirements.

If the truck has an auxiliary in-frame battery box, then it must be relocated if the box is directly under the FSM. Off gases from the batteries may otherwise accumulate within the covers of the FSM creating a potential hazardous situation. The in-frame battery box should never be directly under the FSM.

If the truck is equipped with a pogo stick assembly, then the assembly may need to be relocated to clear the fuel storage module.

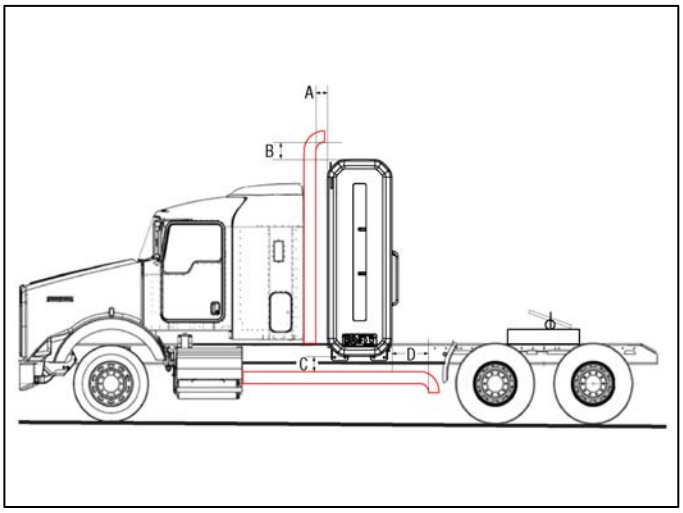


Step 4 Inspect Heat Sources

Due to the construction of the FSM and the location of the CNG cylinder relief devices, Quantum has an additional requirement to add additional heat shielding if a heat source is within 5“ (127mm) of the CNG cylinder covers or to relocate the heat source.

If the heat source is within 8” (204 mm) of the FSM cylinders, adjustments MUST be made in the installation to increase the distance between the heat source and the FSM.

See your truck equipment supplier for heat shielding solutions.



Step 5 Installation Checklist

Refer to the illustrations and dimensions in the *General System Specifications* section of this manual to answer the items on the checklist below.

Distance from outside of rail to the outside of rail ..... _____

Gap between the FSM mount and the outside of rails ..... _____

Will shims be required? ..... Circle: YES / NO

Distance from the back of the driver's cab to the FSM ..... _____

Does this distance exceed the minimum specification? ..... Circle: YES / NO

Distance from the FSM to the kingpin ..... _____

Does this distance exceed the minimum specification? ..... Circle: YES / NO

Verify the locations of the holes to be drilled in the frame are appropriate ..... Circle: YES / NO

Verify the actual size of the drill templates printed from the manual (if used) ..... Circle: YES / NO

Verify all other measurements to ensure the FSM will fit the target area ..... Circle: YES / NO

Have all sources for obstructions been resolved? ..... Circle: YES / NO

Have all sources for heat been resolved? ..... Circle: YES / NO

You will need the following information available to ensure the system, once installed, will be a safe and legal installation:

- Vehicle frame width (outside of frame to outside of frame).
- Distance from the back of the driver's cab to the FSM.
- Distance from the FSM to the kingpin.
- Specifications for the fuel storage module. Refer to *General System Specifications* in this manual.

Once you have determined that the fuel storage module can be properly installed and meet all the necessary requirements, you can proceed with drilling the frame to support the FSM.

Step 6 Frame Drilling Guidelines

The drilling of the frame side member presents no unusual difficulty. Standard high speed steel drills of good quality will serve provided they are sharpened properly and not overheated during sharpening or use.

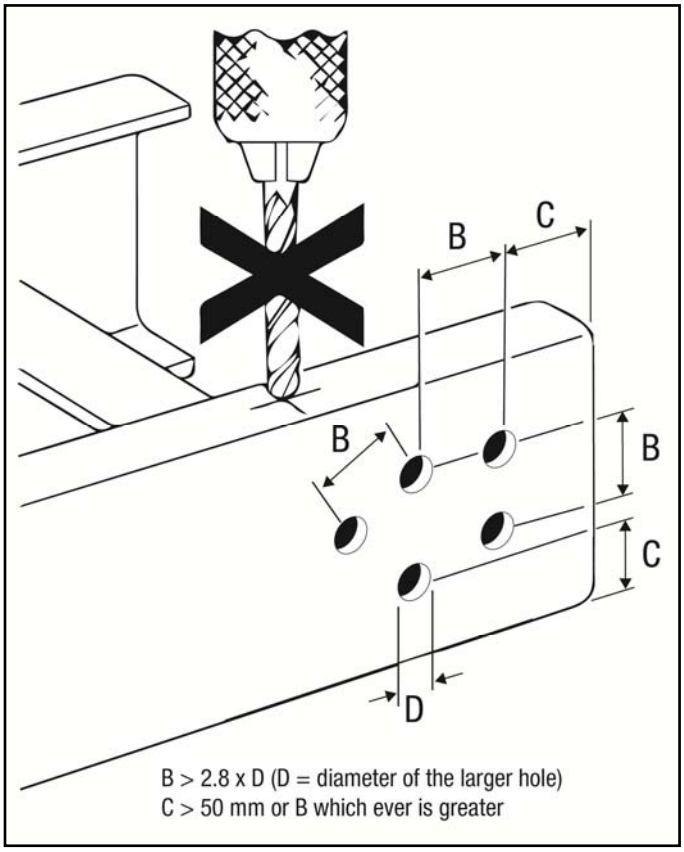
It is recommended to follow these guidelines when drilling holes in vehicle frames:

- Use existing holes whenever possible.
- Do not weld filler pieces into any unused holes of the chassis frame.
- Do not flame cut holes.
- Do not drill holes into the restricted areas of the frame rails.
- It is not recommended to remove the factory installed huck bolts.
- To prevent the forming of cracks from the drilled holes, the holes must always be deburred by 45° chamfering (on both sides) and subsequently treated with primer and paint.
- Add hardware to the existing / open holes and torque to specification.

Hole Location Guidelines

The following recommendations should be considered when determining where to drill the holes in the frame members:

- Never drill holes in the flanges of the frame members.
- Never drill holes in the tapered end of the rear frame cutoff.
- The drilling of holes less than 2” (51mm) from a bend in the chassis frame is not recommended.
- Maintain a minimum distance of 2.8 times the diameter of the largest hole between holes.
- There should not be more than three holes located on a vertical line.
- Bolt holes should be no larger than is required for the size of bolts being used, in no instance larger than 11/16 (17.5 mm).
- If reinforcements are used, avoid drilling holes closer than 2.0 inches (51 mm) from the ends of the reinforcement.



FSM Base Mount Hole Location Considerations

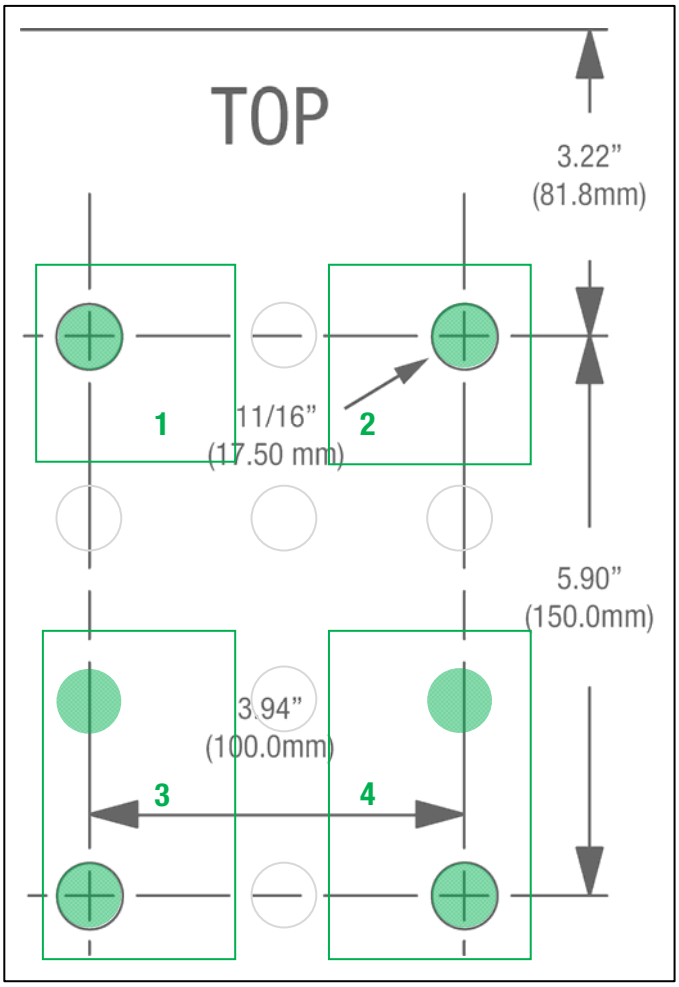
In some instances, there may be pre-existing holes drilled into the frame. If pre-existing holes are in the location where the base mount of the FSM is to be mounted, then the following should be addressed:

- Pre-existing holes in the frame should be marked and drilled into the FSM base mount. The drill should be the same size as the pre-existing hole in the frame. Do not enlarge any holes. Insert fasteners through the holes and torque the fasteners to appropriate specifications. Pre-existing holes drilled into the FSM base mount with fasteners does not substitute use of the M16 fasteners provided with the installation kit.

- If a 11/16" base mount hole (one that uses the M16 bolt from the installation kit) needs to be relocated, then mark and drill a hole in the new location following the *Hole Location Guidelines* in this manual. There must be one 11/16" hole or equivalent in each of the four quadrants as shown in the illustration on the right.

A 5/8" bolt (Grade 8 or better) is a suitable replacement to the M16 bolt supplied with the installation kit if required.

For special considerations, contact Quantum Technical Assistance at 800/816-8691.



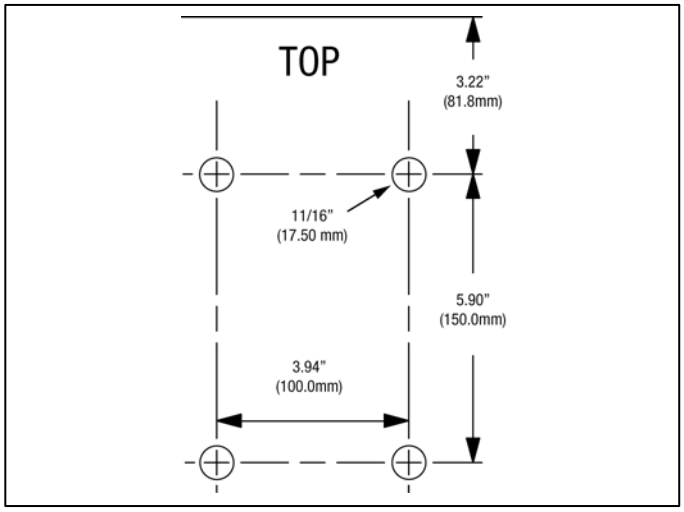
FSM Installation

1. Secure the truck making sure the wheels are chocked and is on level ground.

2. Locate the FSM mount positions on the vehicle frame following the *General System Specifications* mentioned in this manual.

3. Verify that the FSM will have adequate clearance around all sides and from the kingpin.

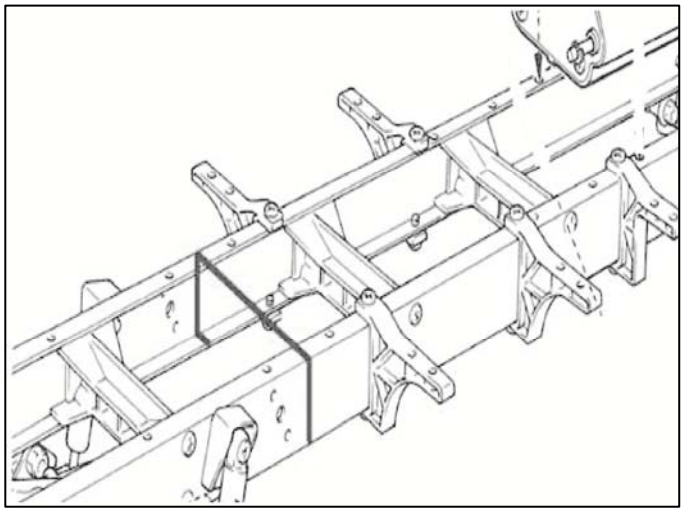
4. Mark the hole locations. The bolt pattern and template for the FSM mount can be found in *Appendix A*. Make sure that the bolt pattern is level with the frame and not level with the ground. Measure the bolt pattern only to be level to the frame.



5. Confirm there are no obstructions on the frame and ensure the area inside the frame is clear of components or lines that may be damaged during the drilling operation.

6. Drill the marked holes for the FSM mounts. The holes should be drilled to 11/16” (17.5mm) or to match the existing holes.

7. Clean any burrs from the holes and coat the holes with a zinc rich primer or equivalent anti corrosion coating.

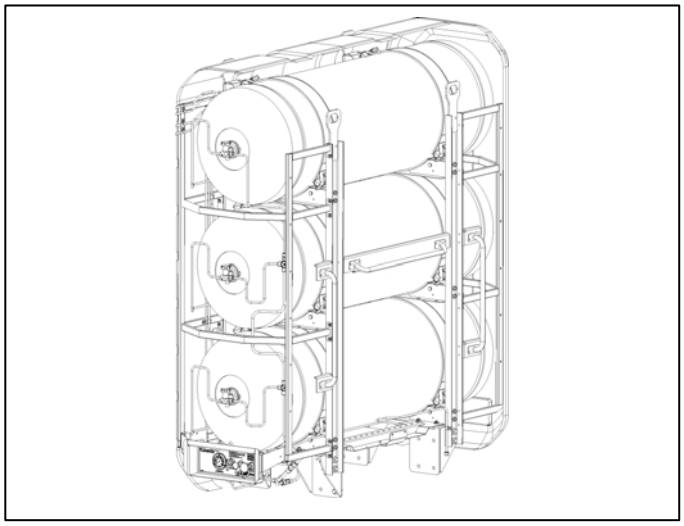


NOTICE

The fuel storage module covers are painted and are categorized as Class A finish. Follow all protective guidelines when working with Class A finishes.

8. Unpack the FSM from its shipping container. The FSM will be fully assembled within the container.

9. Unscrew the rear FSM cover and side covers. Disconnect the electrical connectors for the load lights on the rear cover. There is a connector at the base of the rear panel which separates the load lights from the main harness of the FSM.



10. Remove the grab handles and associated hardware. The rear cover is painted and has a Class A finish, it will take 2 persons to safely remove the rear cover. Finally, carefully set the covers in a location where they will not get damaged.

11. Locate the 4 lift points on the FSM. Refer to the *Module Lifting* section within this manual for more information.

12. Connect the chain, straps, or lifting fixture to the rear lifting points.

13. Connect the chain, straps, or lifting fixture to the front lifting points. The front cover will still be on the FSM so care must be taken not to damage the Class A finish of the front cover.

14. Using a minimum of 2 people, position the FSM onto the frame of the truck. Align the holes on the FSM with the holes drilled into the frame.

DANGER

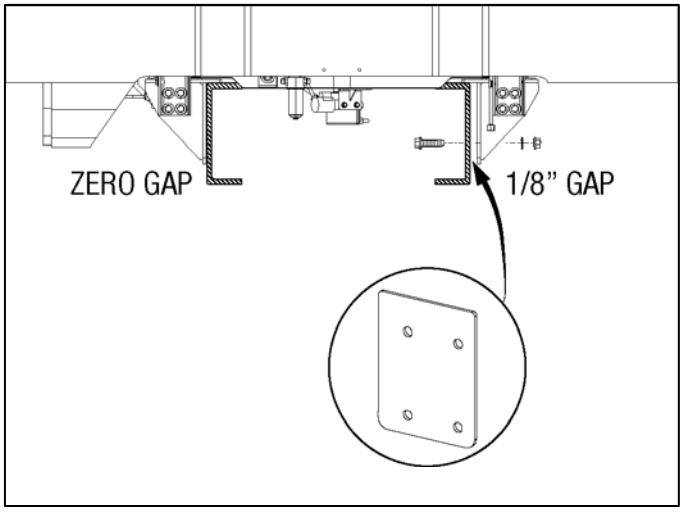
The FSM has been approved to be installed with the front of the FSM facing forward. The correct installed position can be confirmed with the fill panel on the driver's side of the frame. Failure to install the FSM in the correct approved position may result in death or serious injury.

15. Slide one side of the frame so that it is flush with the FSM base mount. The other side of the frame may have a gap that exceeds 1/16". If the gap is greater than 1/16", then a shim will need to be installed.

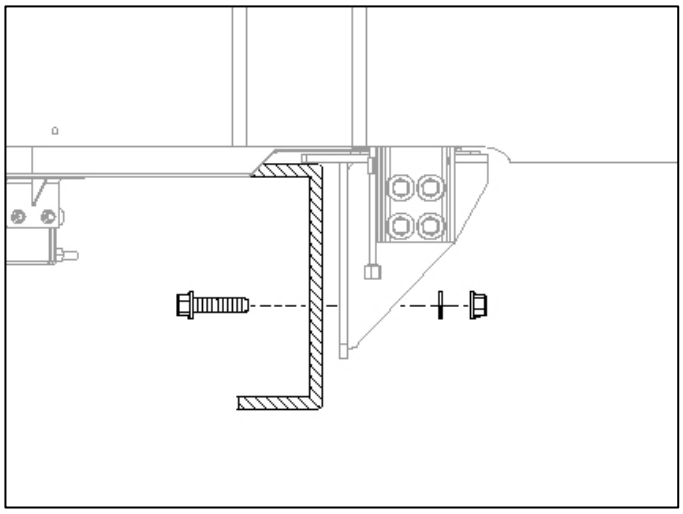
    Insert the appropriate number of shims until the gap is less than 1/16". Shims must be installed equally to both mounting flanges of the base on the same side of the vehicle.

    It may be necessary to match drill the shims to the frame and base mount.

    There are (2) 1/8" shims and (2) 1/16" shims included with the FSM kit. Additional shims can be purchased if required. Part numbers for shims can be found in the *Accessories* section of this manual.



IMPORTANT: ***If existing holes are to be used, the supplied hardware may not be sufficient for full nut engagement. New hardware may be required if additional length is necessary.***

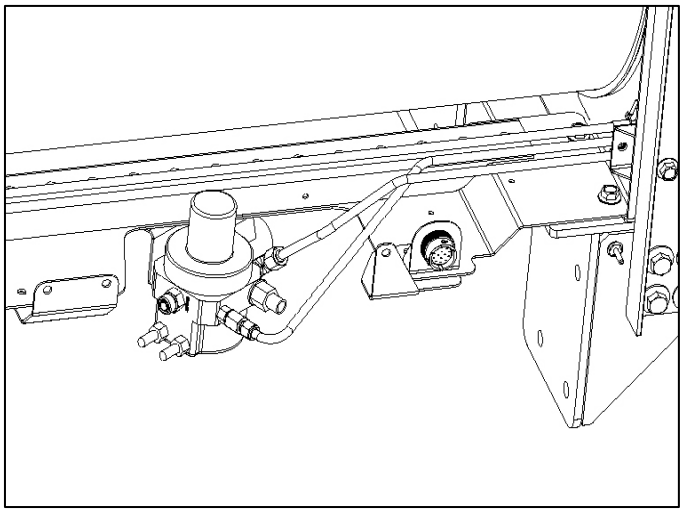


16. Lubricate the 11/16" both threads with 10w oil.

17. Install the fasteners through the mount holes on the FSM and the holes drilled through the frame. Each fastener must include a bolt, flat washer, and a locking nut.

    The bolts should be installed from the frame side of the assembly with the nuts and washers against the FSM mounts. Always torque the nut versus the bolt when possible. Tighten to 180 lb-ft (244 N.m).

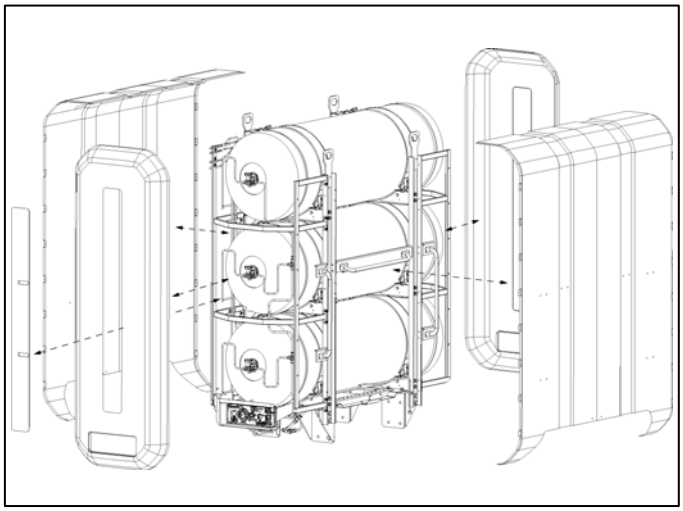
    Do not use a pneumatic impact tools to install any hardware.



18. Connect the coolant lines to the regulator using the two clamps provided with the installation kit. The hot coolant line must be placed on the IN line port. The cool line must be connect to the OUT line port. The lines may need to be trimmed, routed, and clamped properly.

19. Connect the CNG line to the regulator as identified in the *Line Identification* section of this manual. Be sure to route and secure the lines properly.

20. If the FSM is being connected to another CNG cylinder install the stub out pipe kit for the slave cylinder at this time. If not proceed to the next step. The slave cylinder stub out pipe kit can be purchased if needed. Refer to the *Accessories* section of this manual for part numbers. Details can be found in the *Slave Cylinder Connection* section in this manual.



21. Connect the interface harness supplied with the installation kit to the Deutsch HDP24-18-14PN-L017 electrical connector on the front of the FSM.

22. Perform a Start-Up Procedure following the *Start-Up Procedure* section of this manual.

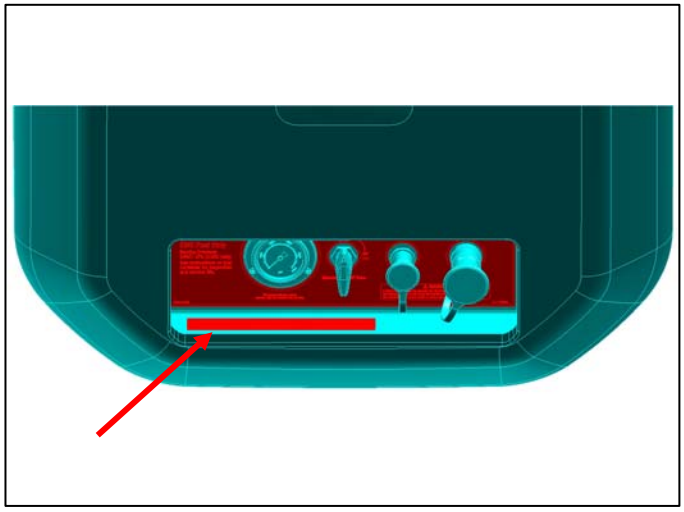
23. Install the rear cover. Tighten fasteners to 62 lb-in (70dNm).

24. Install the side covers and torque to 62 lb-in (70dNm).

25. Inspect the completed fuel storage module assembly and installation; look for any areas that may require additional shielding to protect against road debris, contamination, or heat exposure. Use the following criteria when inspecting the completed assembly for proper clearances and shielding:

- Is any portion of the fuel storage cylinder or cover closer than 5“ (127mm) from any other component or assembly?

- Are there any heat sources within 8” (204 mm) of the FSM cylinders that are unshielded?



Refer to *FSM Cover Modifications* in this manual for additional information and instructions.

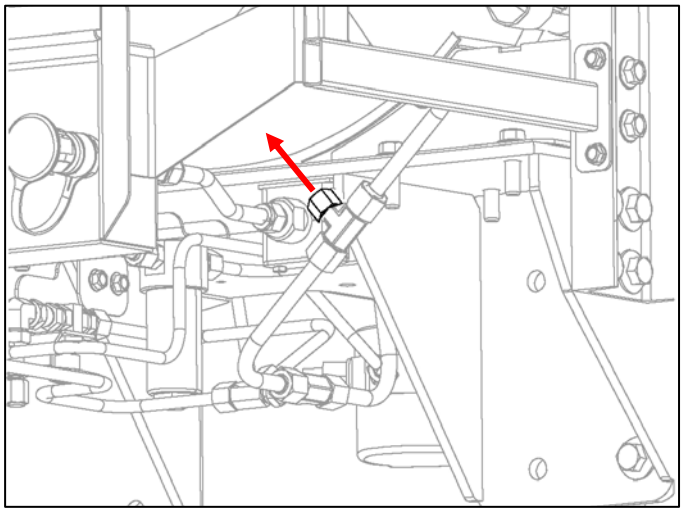
26. Complete the *FSM Final Inspection Form* found in the back of this manual. Refer to *Appendix D* in this manual for the form.

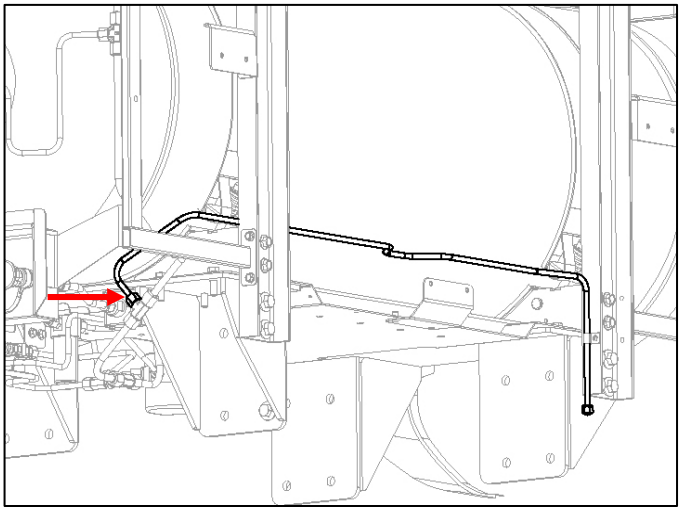
Slave Cylinder Connection

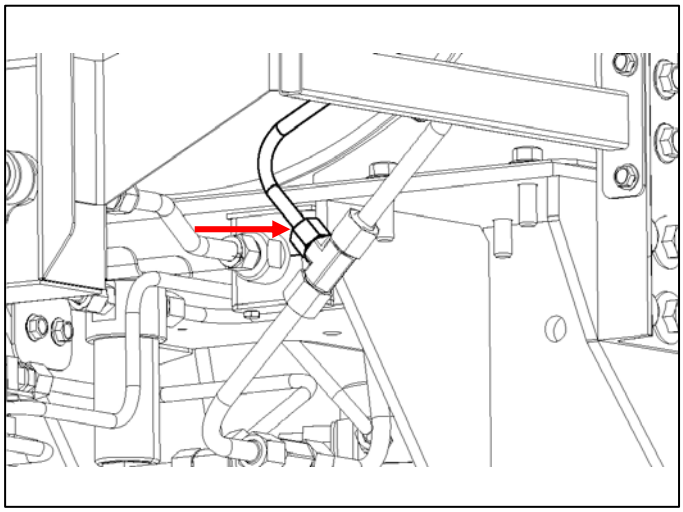
Some FSMs may be ordered with a slave cylinder assembly which will require installation. A slave cylinder stub out pipe is available for purchase in the *Accessories* section of this module.

The T-Connection will be fitted with an O-ring face seal cap. Remove the cap and connect the slave cylinder stub out pipe to the T-Connection. Attach all support hardware.

Once the stub out pipe has been installed, a line must be fabricated to connect the stub out pipe on the FSM to the slave cylinder.







FSM Cover Modifications

Modification of the fuel storage module covers may result in creating a potentially hazardous condition. It is not recommended to modify the covers. Any cover modification may compromise the integrity of FSM covers.

Once you have determined the FSM will physically fit in the target area on the vehicle, you must also inspect for components or brackets on the frame that may interfere with the FSM covers or may even become an abrasion hazard for the CNG cylinder.

You must also evaluate the environment for heat sources, the FSM should be mounted at least 5" (127mm) from any heat source. In the event a heat source is in close proximity to the FSM covers or the cylinder is exposed to direct heat from the heat source steps MUST be taken to protect the FSM and the CNG cylinder.

NFPA 52 States:
6.3.2.1 Fuel supply containers shall be protected with a means to prevent damage that can occur due to road hazards, loading, unloading, direct sunlight, exhaust heat, and vehicle use, including accidental cargo leakage.

6.3.7 Fuel supply containers located less than 8 in. (200 mm) from the exhaust system shall be shielded against direct heat.

Important: *Failure to adequately insulate or protect the fuel storage module and its components may result in damage to the fuel storage module or its components resulting in potential fuel leakage.*

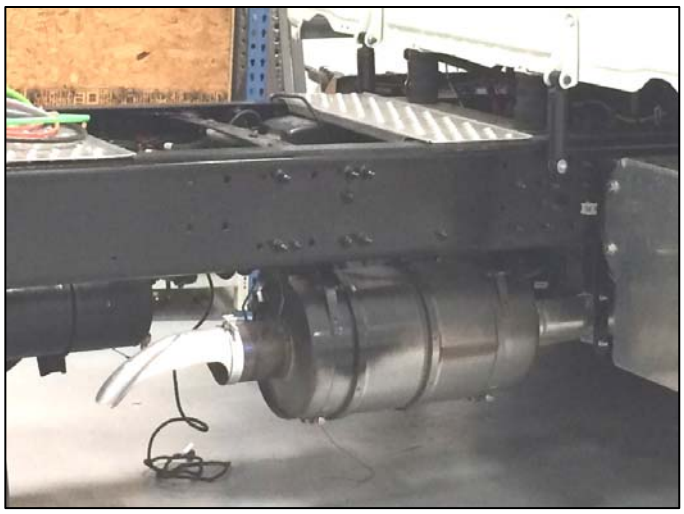
It is the responsibility of the installer to ensure that the fuel storage module and its components are protected against debris and direct heat sources. The following guidelines must be observed before the vehicle is operated using this fuel storage module.

Heat Sources:

Inspect the FSM cover clearances per the *General System Specifications* section in this system.

If possible, move all heat sources away from the fuel storage module to prevent heat transfer.

The FSM should be thoroughly shielded from any heat sources that may radiate to the fuel storage module.



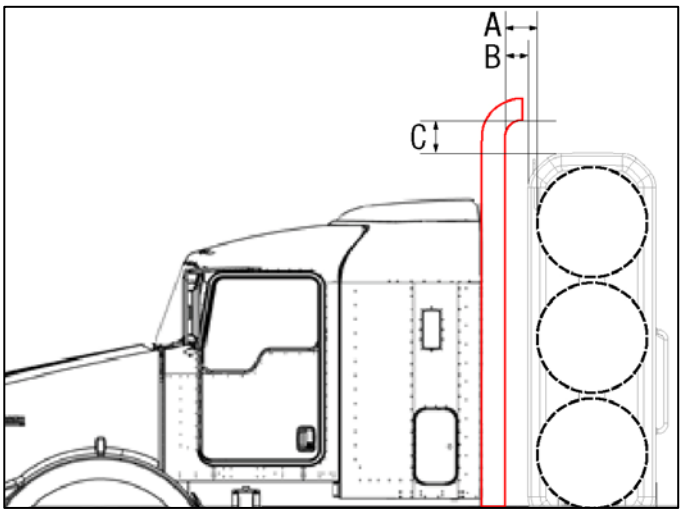
Vertical Exhaust Stack Configuration

In the illustration to the right, a number of heat related issues need to be addressed to make this a safe and approved installation for a vertically mounted exhaust stack.

See your truck equipment supplier for heat shielding solutions.

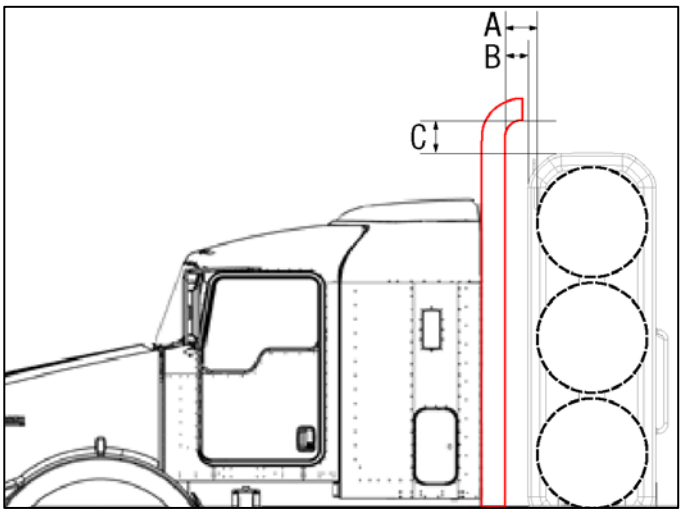
- If a heat source such as an exhaust system component is located less than 5” (127mm) from any FSM cover (B), an additional heat shield, and or a thermal insulating material MUST be placed between the heat source and the CNG fuel storage module.

  A – 8”
  B – 5”
  C – 5”



- If a direct heat source such as an exhaust system component is located less than 8” (204mm) from the CNG fuel cylinder or PRD valve (A), and there is no shield between the heat source and the CNG cylinder, a heat shield MUST be installed.

- The exhaust stack outlet (C) must have a minimum clearance of 5” (127mm) above the FSM.

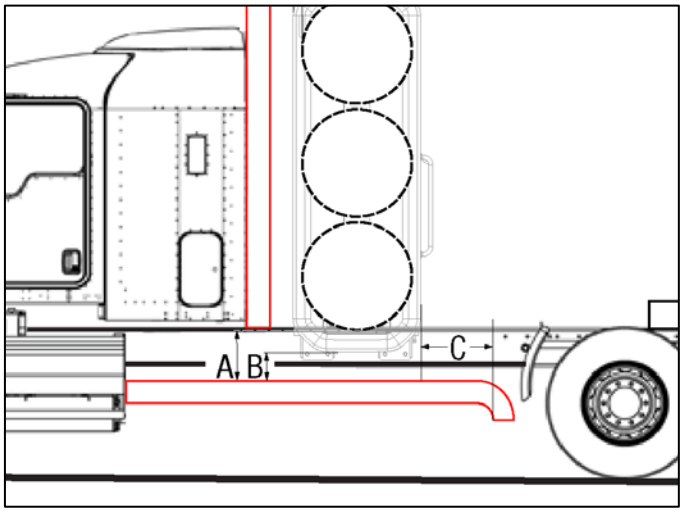


If adequate clearances cannot be achieved between the FSM and the vehicle exhaust system components, it will be necessary to relocate the exhaust system components.

Horizontal Exhaust Stack Configuration

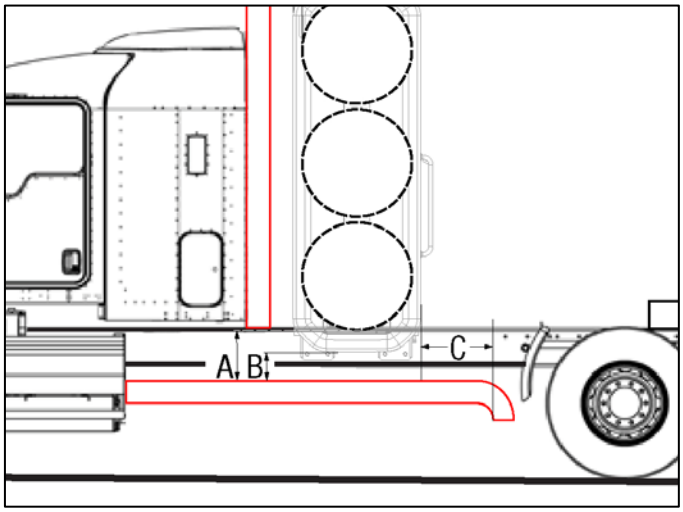
In the illustration to the right, a number of heat related issues need to be addressed to make this a safe and approved installation for a horizontally mounted exhaust stack.

A horizontal heat shield is standard on all units. However, see your truck equipment supplier for heat shielding solutions if more heat shielding is required.



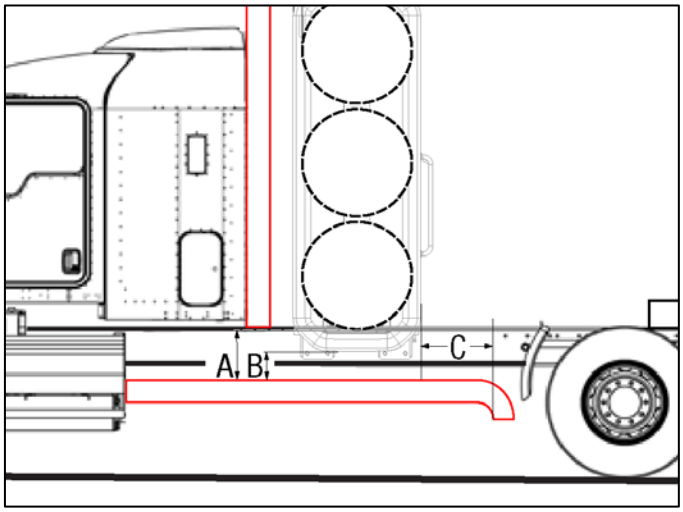
- If a heat source such as an exhaust system component is located less than 5” (127mm) from any FSM cover (B), an additional heat shield and or a thermal insulating material MUST be placed between the heat source and the CNG fuel storage module.

  A – 8”
  B – 5”
  C – 12”



- If a direct heat source such as an exhaust system component is located less than 8” (203mm) from the CNG fuel cylinder or PRD valve (A), and there is no shield between the heat source and the CNG cylinder, a heat shield MUST be installed.

- The exhaust stack outlet (C) must have a minimum clearance of 12” (305mm) behind the FSM.



- You will note that the exhaust components are positioned under the FSM covers allowing the CNG cylinder to be subjected to direct heat rising from the exhaust.

  If this opening is not properly shielded, the fuel storage module and/or components could be damaged.

If adequate clearances cannot be achieved between the FSM and the vehicle exhaust system components, it will be necessary to relocate the exhaust system components.

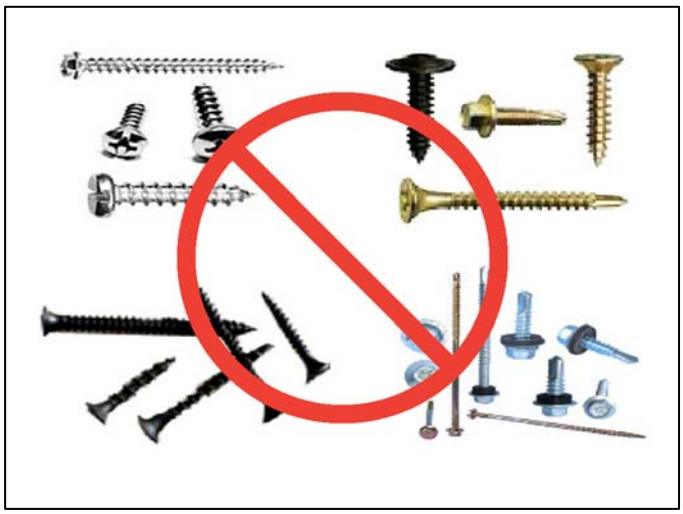
Mounting to FSM Covers

No modifications are recommended to the covers. Altering the covers may compromise the cover's integrity to protect the fuel storage module.

If a fastener absolutely must be added or replaced in the fuel storage module covers, the fasteners must not contact the CNG fuel cylinders.

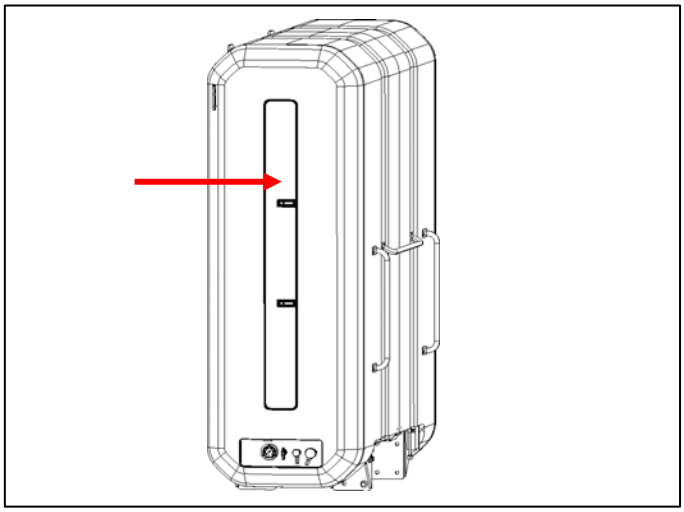
Any fastener that is added to the CNG fuel storage module covers shall not point toward the CNG fuel cylinder. In the event of an accident, these fasteners may damage the CNG fuel cylinder.

DO NOT USE self drilling or pointed fasteners to secure covers or components to the CNG fuel storage module covers.



Debris and Impact Protection

An opening has been made in the FSM cover for access to the interior. If the cover is not secured or left open, debris may enter the interior of the and potentially damage the CNG cylinders or FSM components.



Cover Damage

If a cover becomes damaged, contact Quantum for a replacement. Be sure to have the serial number for the cover available when ordering.

Start-Up Procedure

Purge Instructions

The purge process dilutes the contents of the cylinder to a level that significantly limits the potential flammability range of any gases present in the cylinder.

Purging the CNG cylinder is an important step that should be performed before a cylinder is filled with CNG and or any time the cylinder has been open to atmosphere. Cylinder purging should also be performed to dilute the CNG concentrations within the cylinder any time a cylinder has been drained and will require service or shipping.

⚠ WARNING

Do not allow atmosphere to enter the fuel storage cylinder during purging. The fuel storage cylinder pressure should remain higher than atmospheric pressure during the purging process. Introduction of atmosphere (oxygen) in the cylinder may create a combustible mixture that if ignited, may result in serious injury or death.

NOTICE

Quantum recommends the use of clean, dry, inert gas (Nitrogen, >99.5% purity) for this procedure. If it is necessary to use flammable gas, this procedure should be performed after the CNG cylinder vehicle installation is completed

Prior to the initial fill with CNG, or any service the cylinder should be purged.

Only perform the purge process when the ambient temperature is above 0^0F (-18^0C). If cylinder was stored at temperatures below 0^0F (-18^0C) allow cylinder to warm up to room temperature >60^0F (15^0C) before proceeding.

A recommended purge procedure can be found in the *CNG Cylinder Installation and Maintenance Manual* available at www.qtww.com/service.

To vent the purge gas from the fuel storage module, refer to the Fuel Cylinder Venting procedure in this manual.

Cylinder Initial Pressurization/CNG Cylinder Valve Initial Interface Leak Test

⚠WARNING

Never pressurize a CNG cylinder that is not restrained by approved brackets properly mounted or otherwise acceptably restrained to prevent movement while under pressure. Failure to observe this warning may result in death or serious injury.

⚠CAUTION

Compressed Natural Gas (CNG) is extremely flammable. If something accidentally ignites it, you could be badly burned. Keep sparks, flames and smoking materials away from natural gas. Do not smoke if you are near natural gas or refueling your vehicle.

⚠CAUTION

Compressed Natural Gas (CNG) is stored in the fuel cylinder at pressures up to 3,600 psi (24.8 MPa) at 70°F (21°C). To prevent personal injury:

Never fill to a pressure greater than 3,600 psi (24.8 MPa) at 70°F (21°C).

Never fill a leaking or damaged cylinder.

⚠CAUTION

Verify any equipment used is rated for the highest pressure that can be generated during the procedure. Failure to do so may result in injury.

⚠CAUTION

Failure to follow the initial pressurization instructions may irreversibly damage the fuel storage cylinder, leading to CNG leakage. Fuel leakage may result in personal injury or damage to the vehicle.

⚠CAUTION

Performing this procedure when the CNG cylinder temperature is less than 0^0 F (-18^0 C) may result in damage to the cylinder. Allow the CNG cylinder to warm to room temperature >60^0 F (13^0 C) for a minimum of 12 hours before pressurizing. If ambient conditions where test is performed are less than 0^0 F (-18^0 C), complete the procedure within ½ hour after removing cylinder from room temperature environment. Failure to follow this requirement may result in injury.

NOTICE

When a cylinder is pressurized from empty, a small quantity of AIR (not fuel) is compressed out from between the liner and composite shell. This may cause bubbling around the surface of the shell and/or the end bosses during leak tests. This is a normal condition known as "permeation" and the bubbling should subside typically within 30 minutes. If there is any doubt leave the cylinder pressurized overnight. If the pressure is unchanged and the bubbling has subsided, this is considered normal permeation of entrapped air.

You may also observe some cracking or popping sounds coming from the cylinder during the initial pressurization. If the liner has settled away from the shell during shipping, some cracking or popping noises may be heard during the initial fill; you may also be hearing the shell of the cylinder settling as it is pressurized. If there is no damage to the cylinder, and no fuel leakage is detected, there should be no concern pressurizing the cylinder.

⚠ WARNING

If a leak is detected, immediately stop filling the system. Failure to follow this instruction may result in serious injury or death.

If while filling the vehicle a leak is detected through the fill valve that is not currently being used, or anywhere else in the system, the fill process should be stopped immediately. They system should not be filled until the leak or leaking component has been repaired or replaced.

The recommended steps for this procedure are outlined in order below:

1. Ensure that the fuel storage module is properly installed in a vehicle or retained in a appropriate test fixture before proceeding.

2. Connect the gas supply to the CNG cylinder or the system fill valve.

3. Slowly fill to 30 bar (430 psig) while listening for gross leakage. Re-test and repair any leaks discovered. When leak test is successfully passed, vent the system through the vent circuit. These steps validate the equipment setup and operation for testing the CNG cylinder valve/PRD interface. Test all connections and interfaces in the circuit with a liquid leak test fluid. Observe all connections and interfaces for bubble formation over a two minute period. If no bubbles are present, continue with procedure. If bubbles are found, close the supply valve and vent the system by opening the vent circuit ¼ turn valve and repair any leak(s) before proceeding.

4. Increase the cylinder pressure to 100 bar (1450 psig). Re-test and repair any leaks discovered. When leak test is successfully passed, vent the system through the vent circuit. These steps validate the equipment setup and operation for testing the CNG cylinder valve/PRD interface. Test all connections and interfaces in the circuit with a liquid leak test fluid.

5. If inert gas was used for this procedure, then vent the cylinder following the Fuel Cylinder Venting procedure in this manual.

Filling your Fuel Storage Module

To ensure proper system operation, it is recommended that the CNG system is filled with CNG that meets SAE J1616 specifications.

⚠CAUTION

Compressed Natural Gas (CNG) is extremely flammable. If something accidentally ignites it, you could be badly burned. Keep sparks, flames and smoking materials away from natural gas. Do not smoke if you are near natural gas or refueling your vehicle.

⚠CAUTION

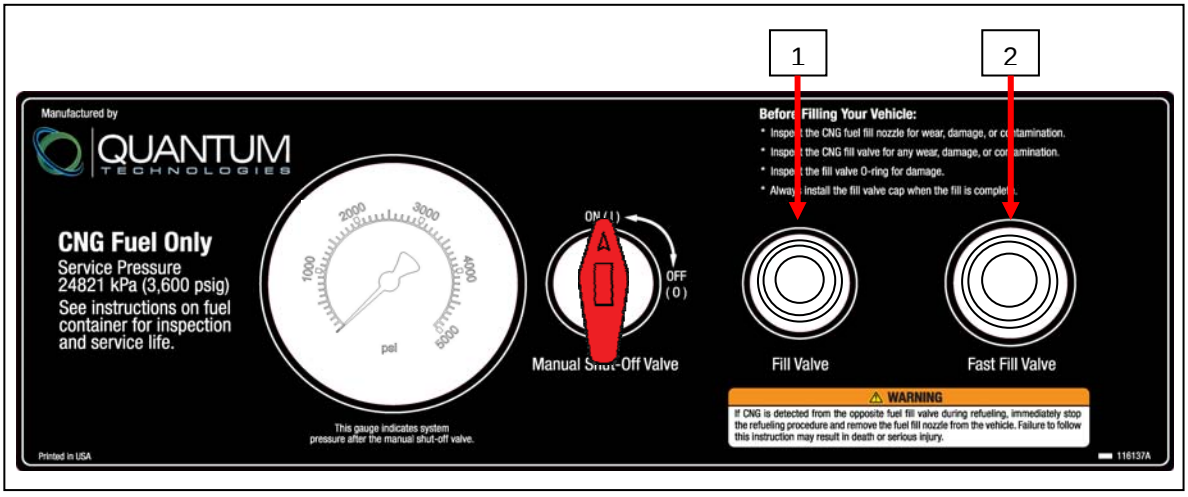
Compressed Natural Gas (CNG) is stored in the fuel cylinder at pressures up to 3,600 psi (24.8 MPa) at 70°F (21°C). To prevent personal injury:

Never fill to a pressure greater than 3,600 psi (24.8 MPa) at 70°F (21°C).

Never fill a leaking or damaged cylinder.

The fill valve panel is located on the fuel storage module end panel assembly.

The fuel system is equipped with two fill valves; a standard NGV 1 compliant 3600 psi fill valve (1) and a high flow, 3600 psi, ISO 14469-2 compliant fill valve (2). Either fill valve may be used with no additional actions required by the system operator.


1
2
Manufactured by
QUANTUM
TECHNOLOGIES
CNG Fuel Only
Service Pressure
24821 kPa (3,600 psig)
See instructions on fuel container for inspection and service life.
psi
ON (I)
OFF (O)
Manual Shut-Off Valve
This gauge indicates system pressure after the manual shut-off valve.
Before Filling Your Vehicle:
Fill Valve
Fast Fill Valve
WARNING
If CNG is detected from the opposite fuel fill valve during refueling, immediately stop the refueling procedure and remove the fuel fill nozzle from the vehicle. Failure to follow this instruction may result in death or serious injury.
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⚠WARNING

If a leak is detected, immediately stop filling the system. Failure to follow this instruction may result in serious injury or death.

If while filling the vehicle a leak is detected through the fill valve that is not currently being used, or anywhere else in the system, the fill process should be stopped immediately. They system should not be filled until the leak or leaking component has been repaired or replaced.

Because CNG is a gas, the amount stored in the CNG fuel cylinder depends on pressure and temperature. The CNG fuel system uses a service pressure of 3,600 psi (24.8 MPa) at 70°F (21°C).

Many CNG fuel stations in the United States presently operate at this pressure. However, some stations in the United States and all stations in Canada presently operate at 3,000 psi (20.7 MPa). This lower refueling pressure will reduce the capacity of your fuel storage system by about 15%.

Also a “fast fill” station heats and expands the natural gas during refueling. A fast fill can reduce the capacity of your fuel storage system by about 15%. A system refueled using a “slow fill” overnight dispenser is not subject to this condition and should receive a full fill.

Fast filling using the high flow fill receptacle may also result in a decreased fuel capacity due to the additional heat generated in the cylinder by the faster filling times.

Some fast fill CNG fuel stations provide temperature compensated refueling. This means that the fuel station will automatically adjust refueling pressure if the outside temperature is very hot or very cold. For example, on a very hot day (100°F (38°C)), the fuel station may provide a refueling pressure of about 4,000 psi (27.6 MPa). This is normal and does not indicate a problem.

To fill your vehicle with CNG fuel, do the following:

1. Turn off the engine and set the parking brake.
2. Turn off all equipment that may produce heat, sparks or flame.
3. Remove the fill valve cap and any debris from the fill valve.
4. Inspect the fill valve O-ring. Make sure the O-ring is seated in the groove. Never connect the fill nozzle to the valve if the O-ring is missing or damaged. Refer to Fill Receptacle O-Ring Inspection in this manual.

⚠CAUTION

Attempting to fill a Compressed Natural Gas (CNG) fuel system that has a missing or damaged O-ring is dangerous. Natural gas can leak. If the natural gas is accidentally ignited, you or others could be injured. Replace the O-ring before filling the cylinder.

5. Connect the CNG fill nozzle to the fill valve and follow the instructions displayed on the fuel dispenser.
6. When finished fueling, disconnect the fill nozzle, return it to the dispenser, and put the fill valve cap back on the fill valve.

Low Ambient Temperature Vehicle Refueling

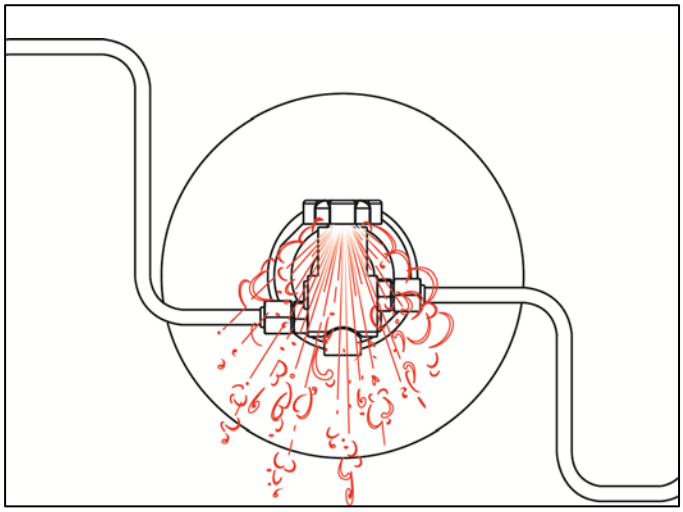
⚠WARNING

Never pressurize a CNG cylinder that is not restrained by approved brackets properly mounted or otherwise acceptably restrained to prevent movement while under pressure. Failure to observe this warning may result in death or serious injury.

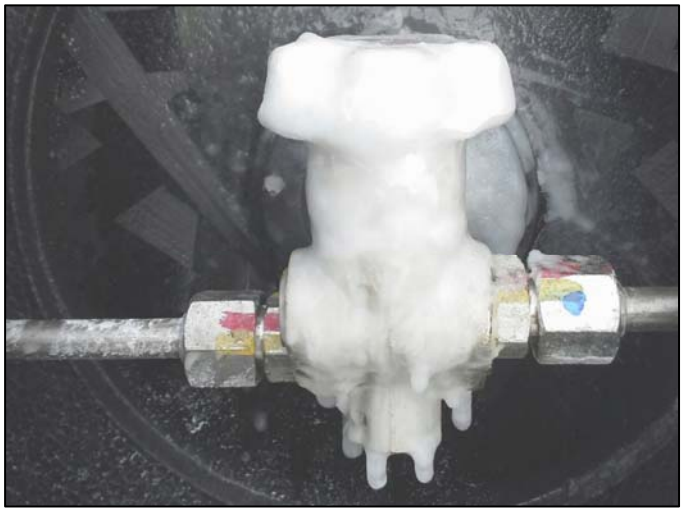
⚠CAUTION

Performing this procedure when the fuel storage module is less than 0^0 F (-18^0 C) may result in damage to the components within the FSM. Allow the FSM to warm to room temperature >60^0 F (13^0 C) for a minimum of 12 hours before pressurizing. Failure to follow this requirement may result in minor or moderate injury as well as damage to components.

Fueling in low ambient temperatures may cause freezing concerns and potential flow restrictions within the fuel storage module. Fueling in low ambient temperatures may result in potential flow restrictions as ice begins to form inside the fuel lines and components. In some cases, the fuel flow may be restricted or entirely blocked due to ice build-up. If the lines are blocked with ice, the ice must thaw before flow resumes.



Cold ambient temperatures may have an effect on system components causing them to temporarily change size and shape. Quantum fuel storage modules are designed to operate at temperatures as low as -40°F (-40°C). Both the rate of fueling and cold ambient temperatures may drop the temperature within the FSM below -40°F (-40°C). When this happens, the soft parts that seal the system may be lose their ability to seal against metallic components which may have changed size and shape. The CNG within the system may escape past the seals and out to atmosphere. Gas escaping past the seals will create a dangerous condition and may damage the fuel storage module components.



Filling at a slower rate in cold ambient temperatures will make it less likely for components to change size and shape. Faster fill rates will create a larger pressure drop which will significantly lower the temperature of the fuel as it passes through the system. Faster fill rates may result in dropping the temperature beyond the -40°F (-40°C) limit.

Also, the quality of fuel has an effect on line freezing. Quantum builds all fuel storage modules to be compatible with SAE J1616 quality CNG.

SAE J1616 1.0 - Water content and other corrosion precursors, heavier hydrocarbons which may condense within the fuel container, particulate matter, oil and energy content need to be controlled in order to minimize corrosion and provide satisfactory low-temperature vehicle operation, performance, and emissions levels.

Refueling Problems

If the system cannot be refueled, check for the following:

- The refueling system is not operating properly
  - Refer to the refueling system operating instructions.

- Refueling nozzle not properly engaged on the fill receptacle.
  - Verify nozzle is fully engaged.

- Cylinders already full.
  - Verify CNG level in the cylinders using the pressure gauge.

- The cylinders have higher pressure than the refueling system.
  - Check the system pressure available from the refueling system and check it against the CNG pressure in the cylinders.

If the items above have been checked and the system still will not take fuel, the system may require service.

Leak Checking the System

⚠WARNING

CNG is extremely flammable. If something ignites it, you could be severely burned.

Keep sparks, flames and ignition sources a minimum of 5 meters from CNG.

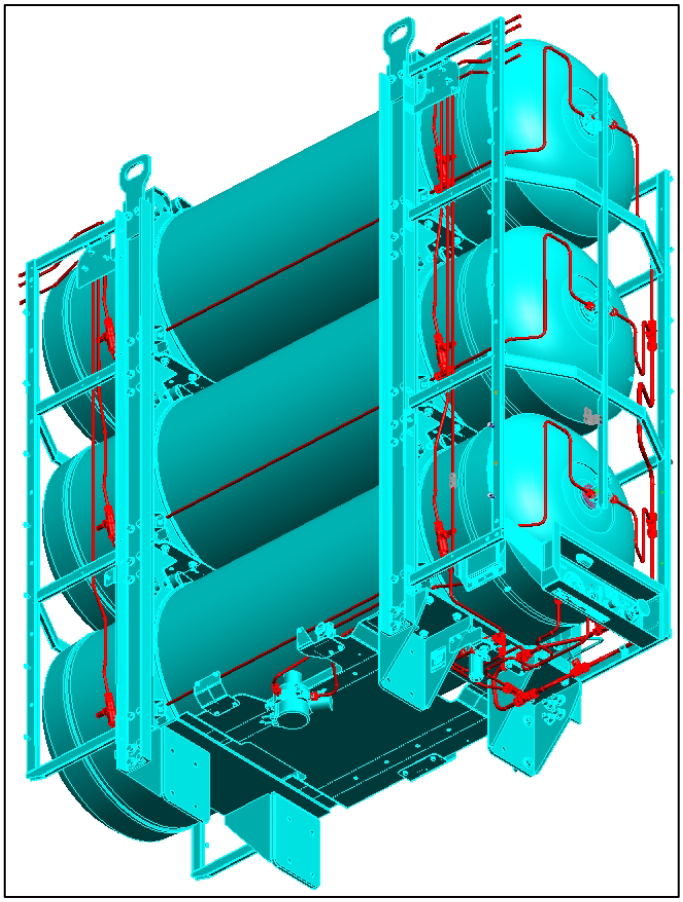
Ensure work area is well ventilated.

Always wear proper eye and hearing protection when working with pressurized gas.

Use explosion proof drop lights when working on gaseous fueled systems.

Failure to follow these basic safety guidelines may result in serious personal injury or death.

Before proceeding with this or any repair or maintenance, read and understand the *Important Safety Information* contained in the front of this manual.



Use this procedure if a CNG fuel system leak is suspected. The system can be checked for leaks after initial power-up, at idle or while the system is operating. Always leak check the fuel system after any service that disturbs fuel carrying components has been performed.

CNG gas is lighter than air and will rise. When using a hand held detector, always check above lines and fittings for best results.

1. Start the system to ensure all fuel lines are pressurized.

   IMPORTANT: ***When leak checking a system is it strongly recommended that the high pressure side is checked at several pressure points (i.e. 500 psi, 1500 psi, 3000 psi, 3600 psi) as leaks may be present at lower pressures and not at higher pressures.***

2. Check the fuel system for leaks by using a CNG gas detector, ultrasonic leak detector, or Snoop®. If using a gas detector, run the detector's probe along the top of all lines, joints, and fittings. Any leaks detected should be repaired before the unit is returned to service.

Fuel Cylinder Venting

⚠WARNING

Failure to use an orifice in the venting system may subject the fuel storage module to extremely low temperatures during venting resulting in severe damage to (or failure of) these components. Use the orifice specified by this procedure when venting the fuel storage module. Failure to follow this instruction may result in death or serious injury and damage components.

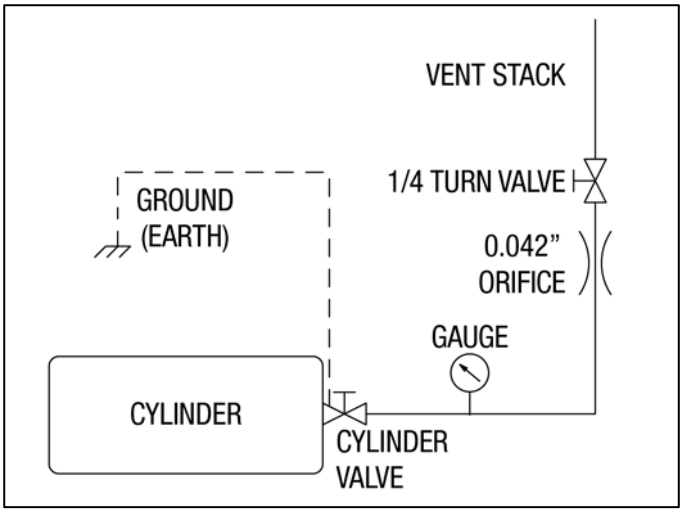
⚠CAUTION

If proper procedures are not followed during fuel cylinder venting serious injury or death could occur. Read and understand all safety information before proceeding with the release of pressurized gas. Refer to *Important Safety Information* in this manual. It is also strongly recommended that the local fire authority be consulted to ensure all local regulations are followed.

All CNG Fuel Cylinders installed in an enclosed area require venting to the outside of the vehicle. Venting systems must meet the requirements of applicable local codes or venting regulations.

Due to the design of Type 4 fuel cylinders there will always be low levels of permeation that may result in a fuel odor in the vehicle if mounted in a passenger compartment.

Quantum does not recommend mounting Type 4 cylinders in enclosed passenger compartments. If a type 4 cylinder will be mounted in a passenger compartment, the entire cylinder and valve connections should be covered with a vent “bag” or system to capture and route any gas that escapes from the cylinder to the outside of the passenger compartment.

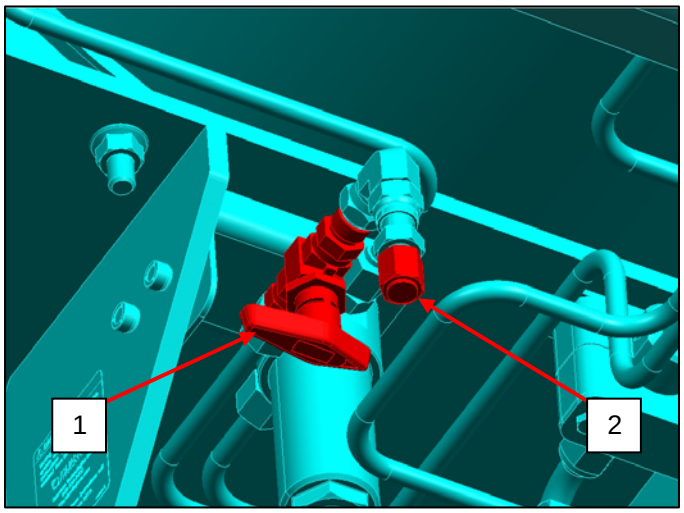


Venting Storage Cylinders

⚠WARNING

Operating the system with the system vent valve in the open position and with the end cap removed, may result in a fuel leak; verify the valve is in the closed position and the end cap is secure before filling or operating the system. Failure to follow this instruction may result in serious injury or death.

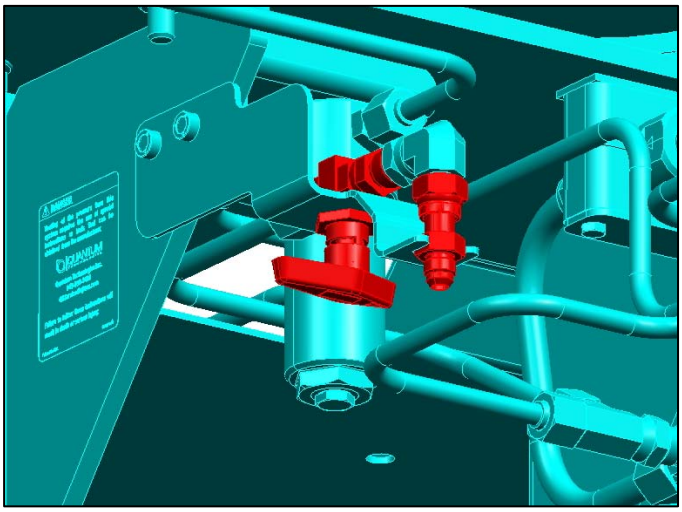
1. Close the manual shut off valves on all fuel cylinders. Refer to *Fuel Storage Cylinder Manual Shut-off* in this manual.
2. Confirm the system vent valve (1) has been turned to the clockwise so that the handle is perpendicular to the line. This is the closed position.
3. Remove the valve port end cap (2) on the outlet port.

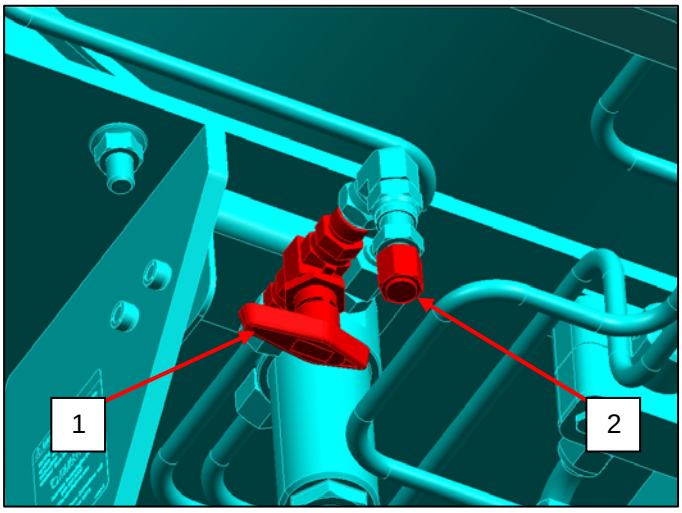


NOTICE

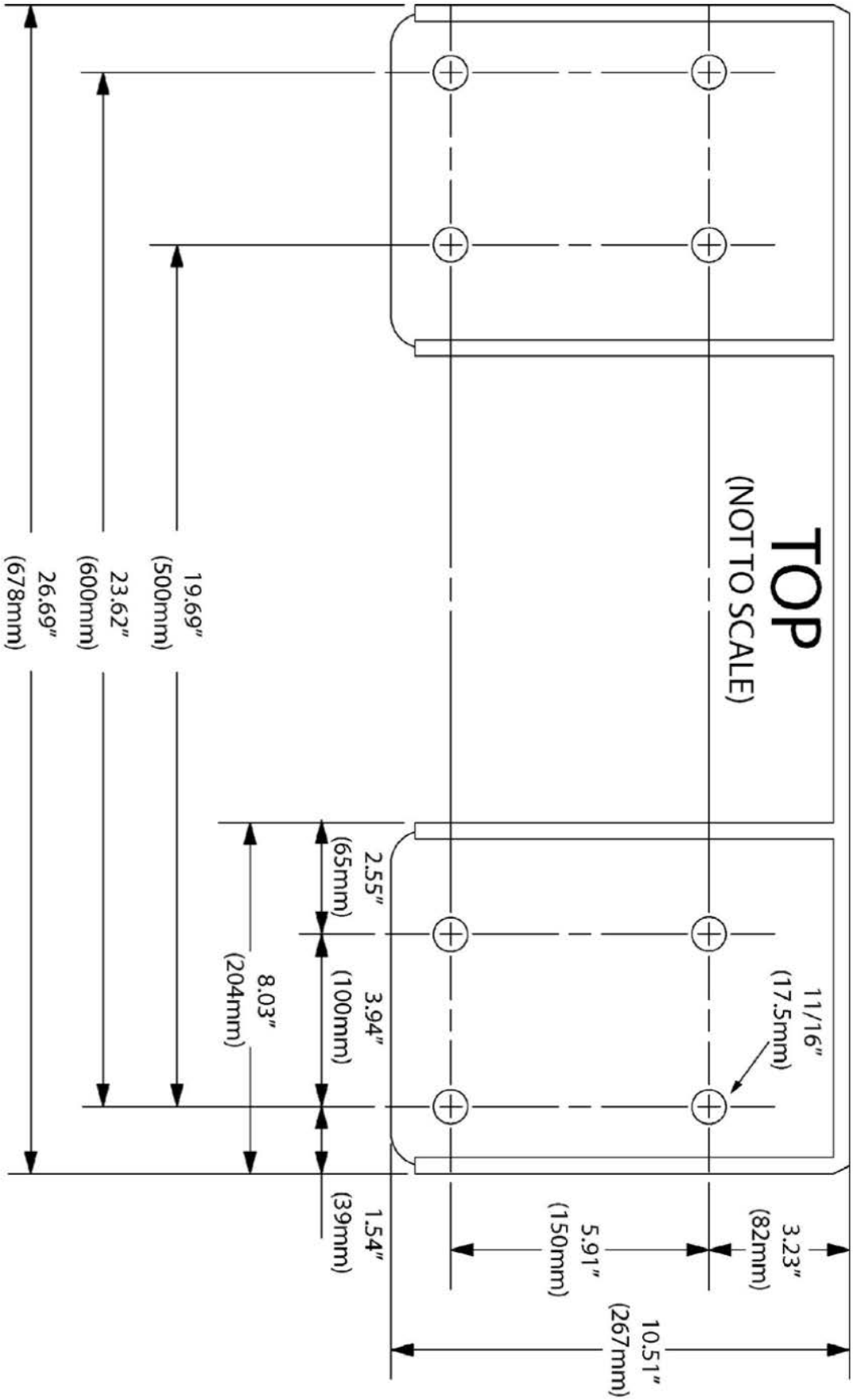
The vent hose must be equipped with a 0.042" (1.06mm) orifice to prevent damage to the cylinder valve.

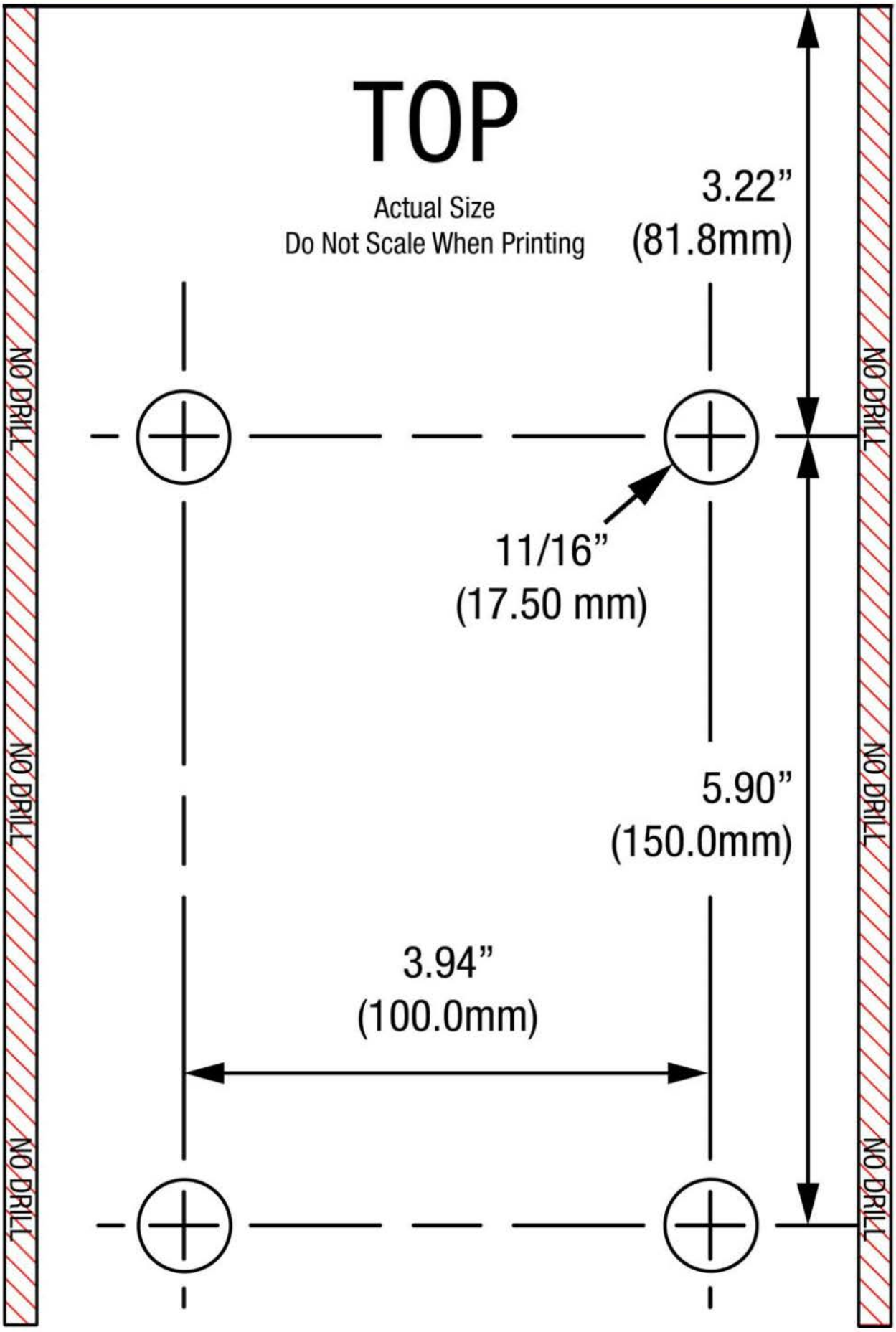
4. Connect the vent line.
5. Open the manual shut off valves on the fuel cylinders to be vented.
6. Slowly open the system vent valve by turning the valve handle counter-clockwise so that the handle is parallel with the vent line.
7. Drain the fuel cylinder to approximately 10 psig ± 5 psig (1.7 bar ±0.3 bar).
8. If the cylinder valve is to be serviced, purge the remaining CNG from the fuel cylinder. Refer to *Purge Instructions* in this manual.
9. After the venting and purge procedures are complete, verify the manual shut off is closed by turning the valve clockwise until it stops.
10. Close the system vent valve (1) so that it is perpendicular to the line as shown.
11. Remove the vent line.
12. Reinstall the valve port end cap (2) and torque to 22 lb-ft (30 Nm).

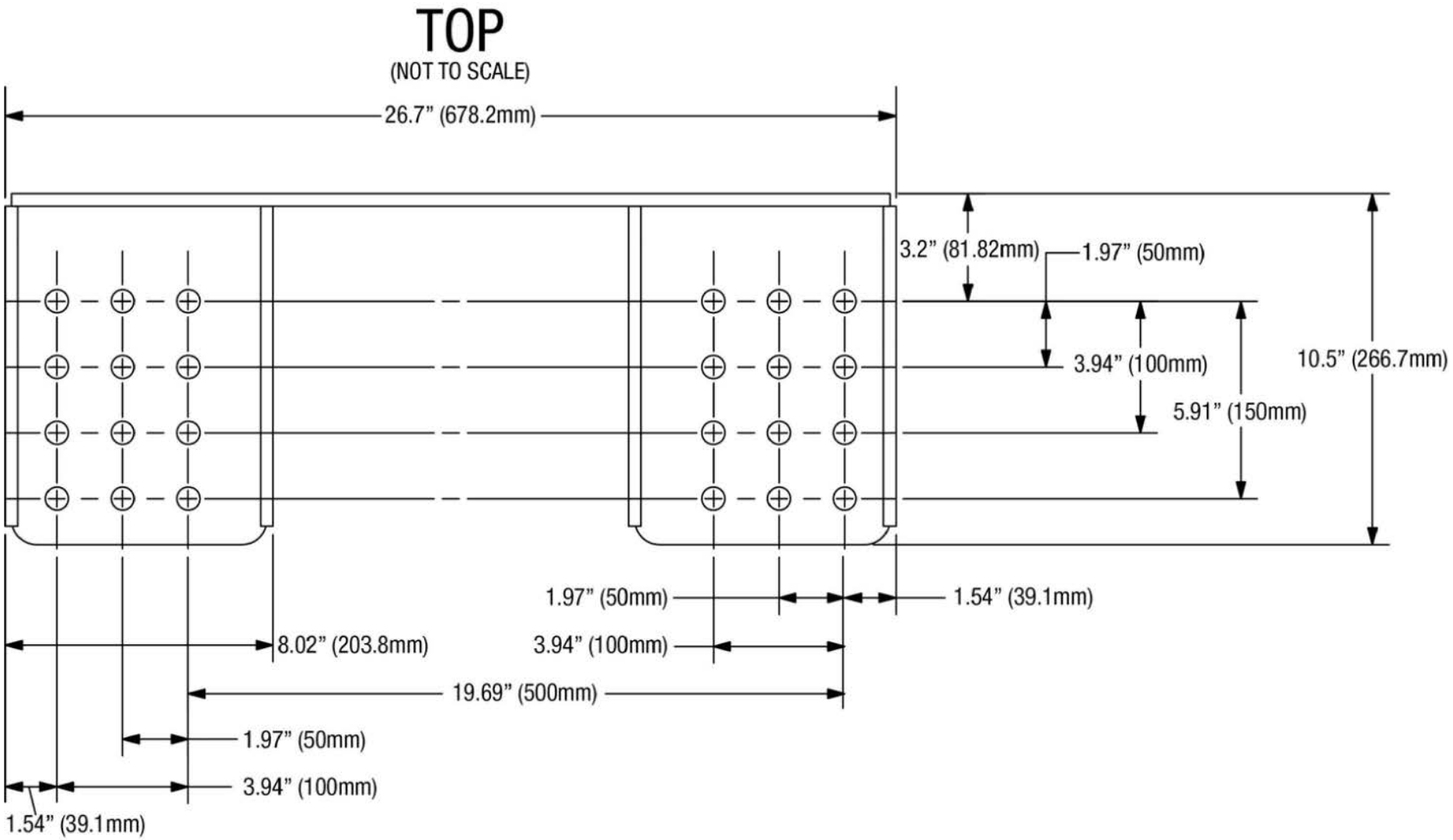


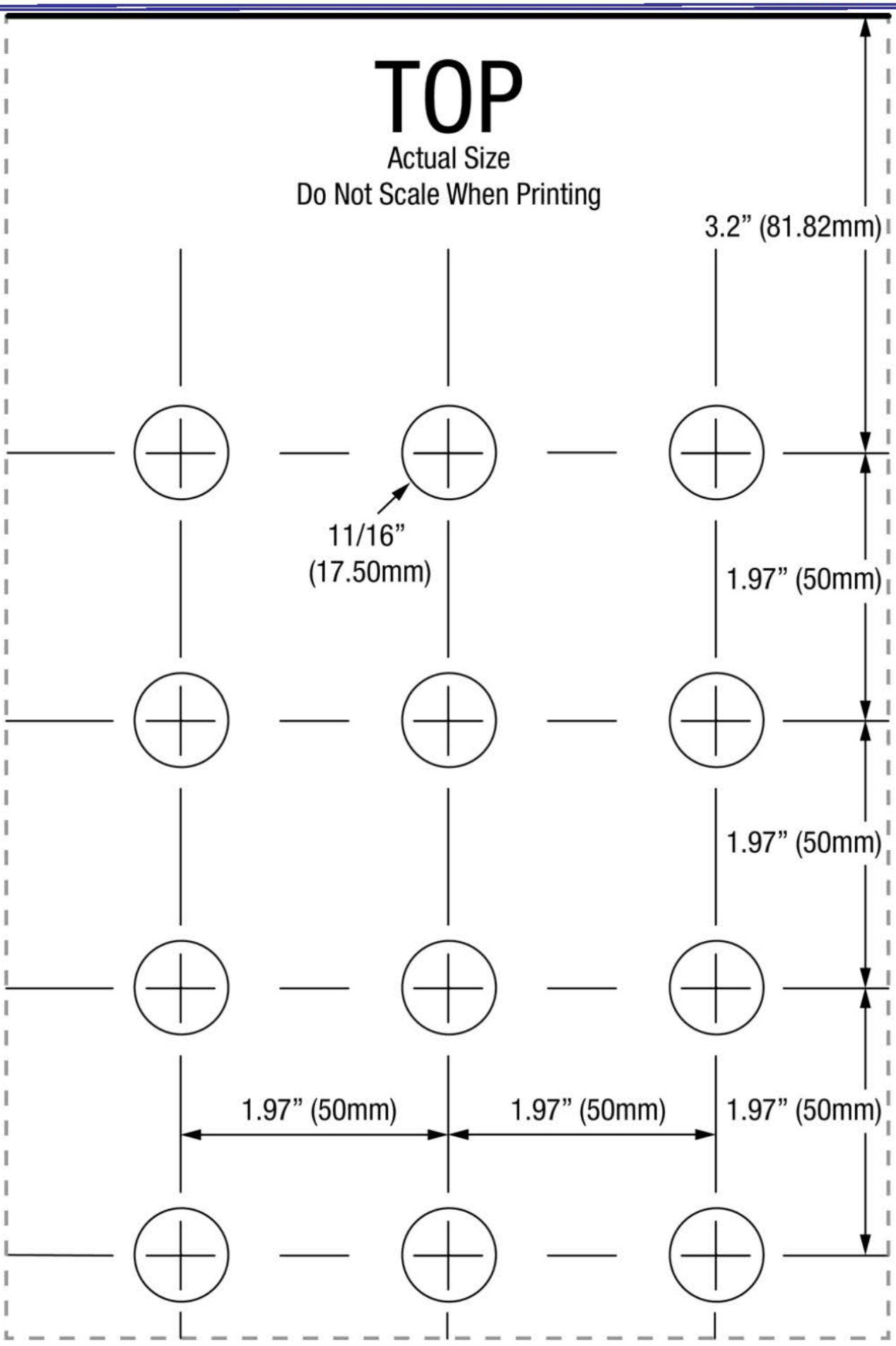


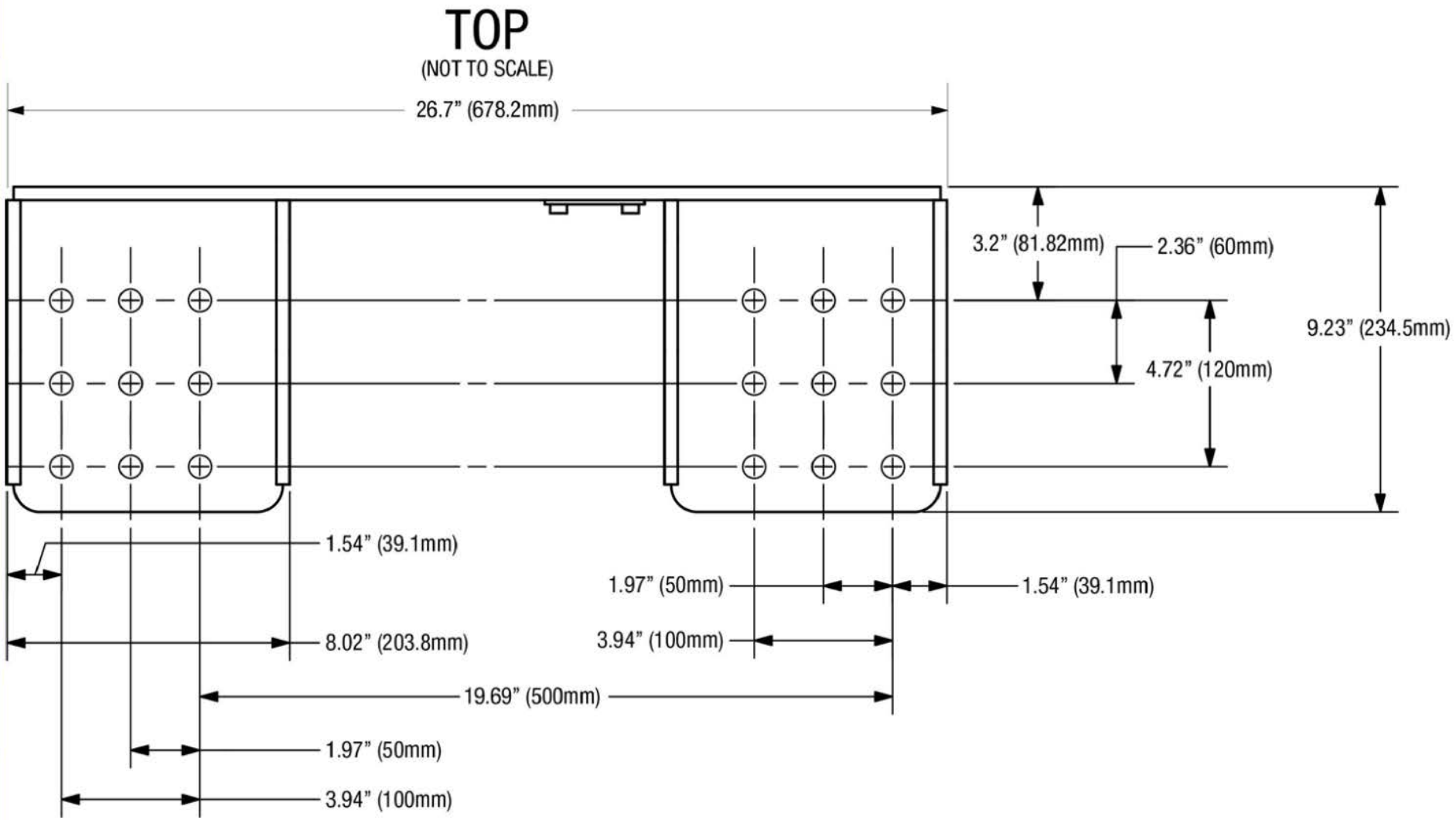
Appendix A – FSM Mount Templates

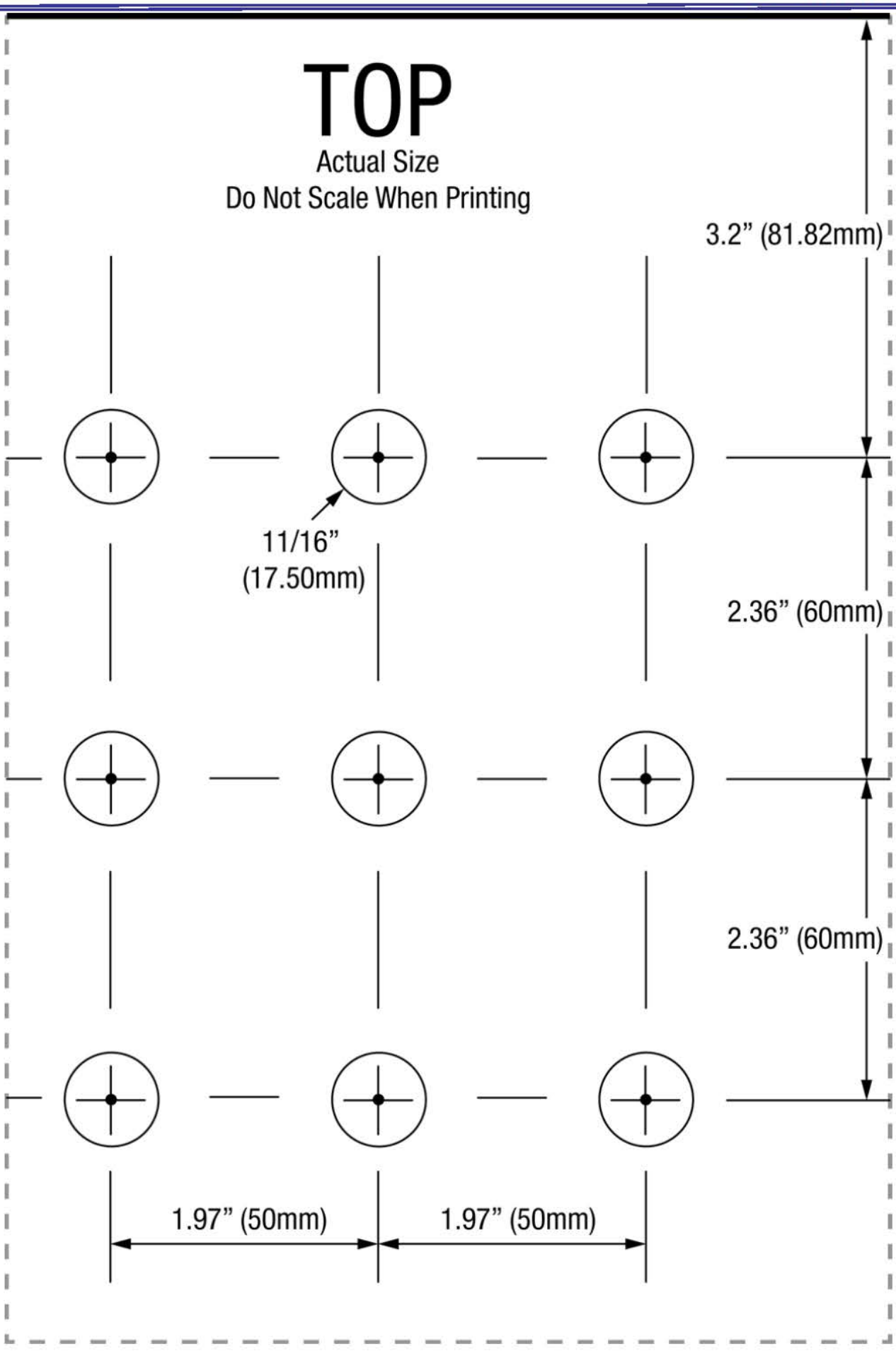



TOP
Actual Size
Do Not Scale When Printing
3.22”
(81.8mm)
11/16”
(17.50 mm)
5.90”
(150.0mm)
3.94”
(100.0mm)
NO DRILL
NO DRILL
NO DRILL
NO DRILL
NO DRILL
NO DRILL

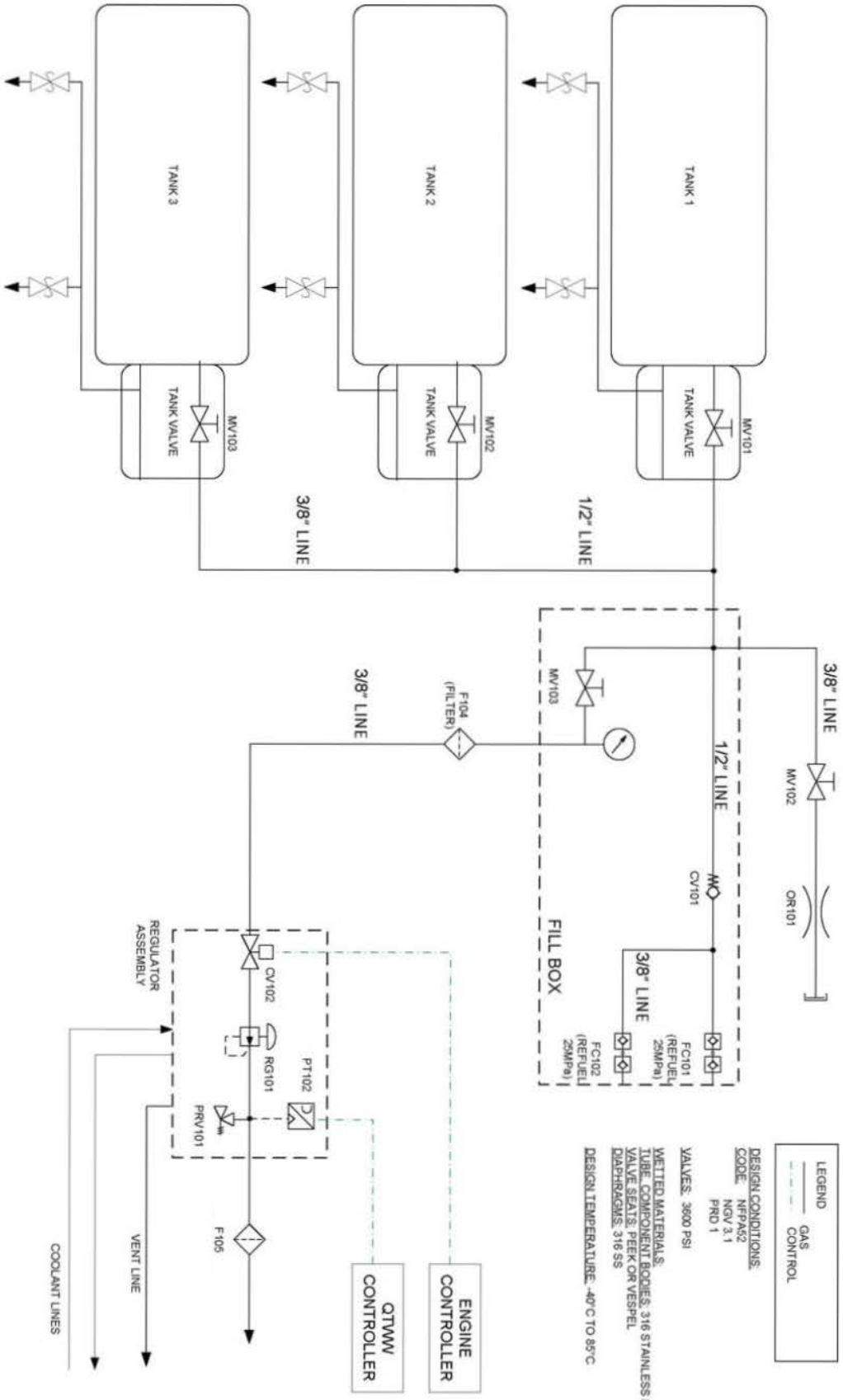

TOP
(NOT TO SCALE)
26.7" (678.2mm)
3.2" (81.82mm)
1.97" (50mm)
3.94" (100mm)
5.91" (150mm)
10.5" (266.7mm)
1.97" (50mm)
1.54" (39.1mm)
8.02" (203.8mm)
3.94" (100mm)
19.69" (500mm)
1.97" (50mm)
3.94" (100mm)
1.54" (39.1mm)


TOP
Actual Size
Do Not Scale When Printing
3.2" (81.82mm)
11/16"
(17.50mm)
1.97" (50mm)
1.97" (50mm)
1.97" (50mm)
1.97" (50mm)
1.97" (50mm)

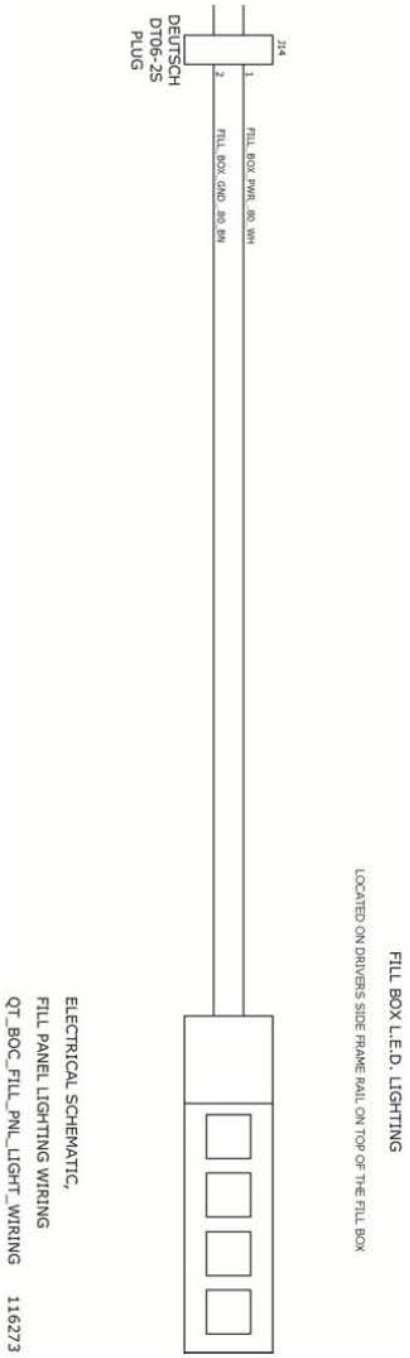

TOP
(NOT TO SCALE)
26.7" (678.2mm)
3.2" (81.82mm)
2.36" (60mm)
9.23" (234.5mm)
4.72" (120mm)
1.54" (39.1mm)
1.97" (50mm)
1.54" (39.1mm)
8.02" (203.8mm)
3.94" (100mm)
19.69" (500mm)
1.97" (50mm)
3.94" (100mm)

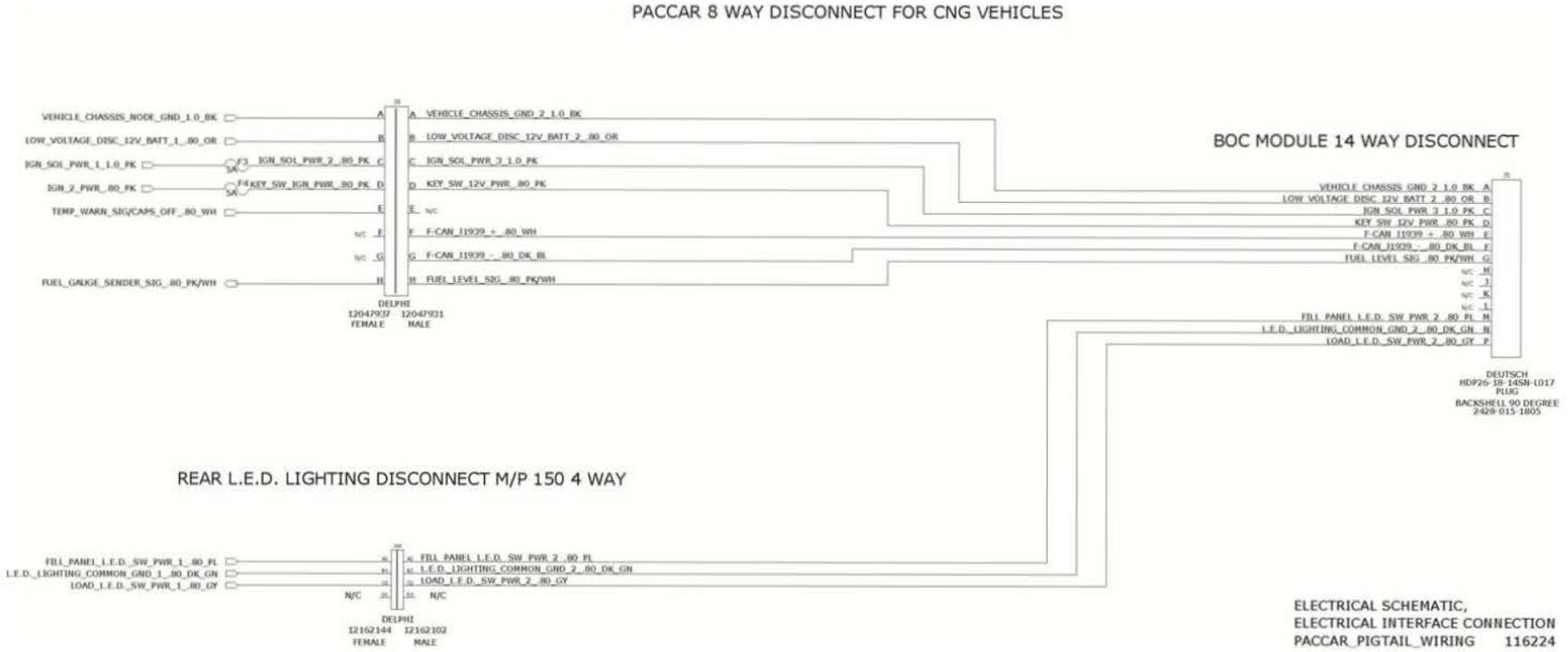

TOP
Actual Size
Do Not Scale When Printing
3.2" (81.82mm)
11/16"
(17.50mm)
2.36" (60mm)
2.36" (60mm)
1.97" (50mm)
1.97" (50mm)

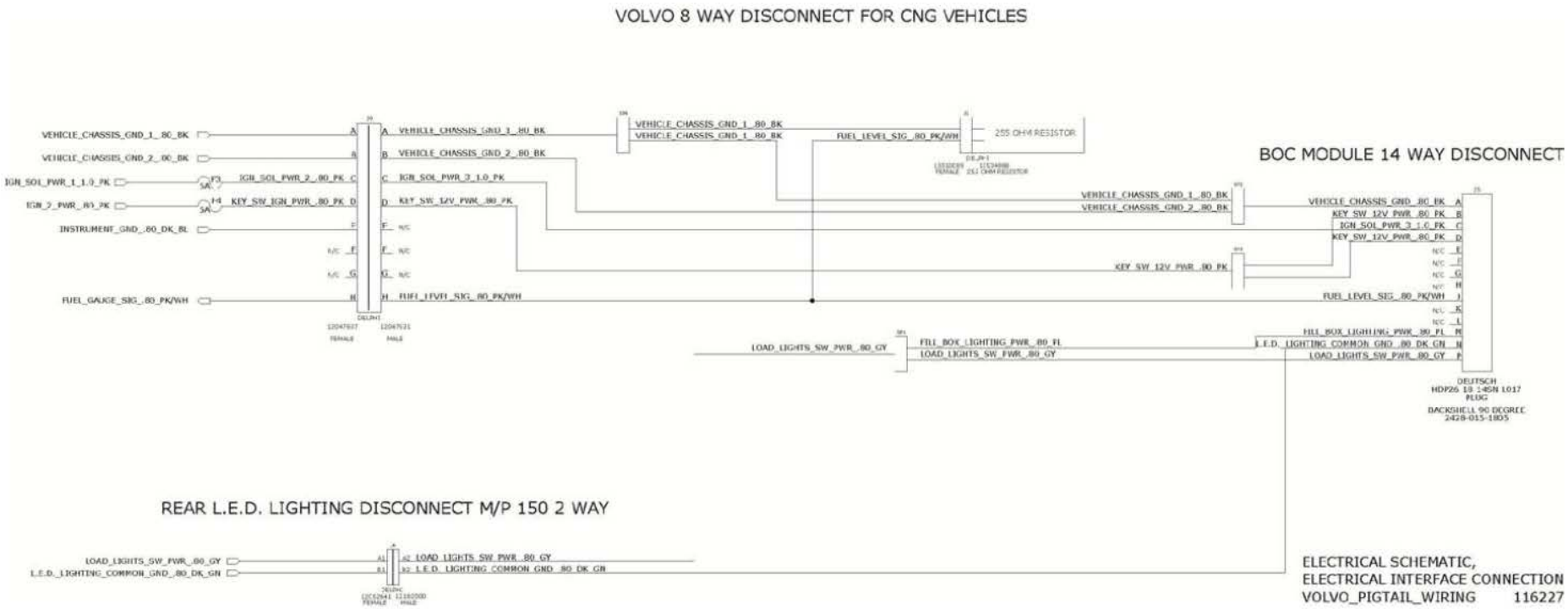
Appendix B – System Mechanization

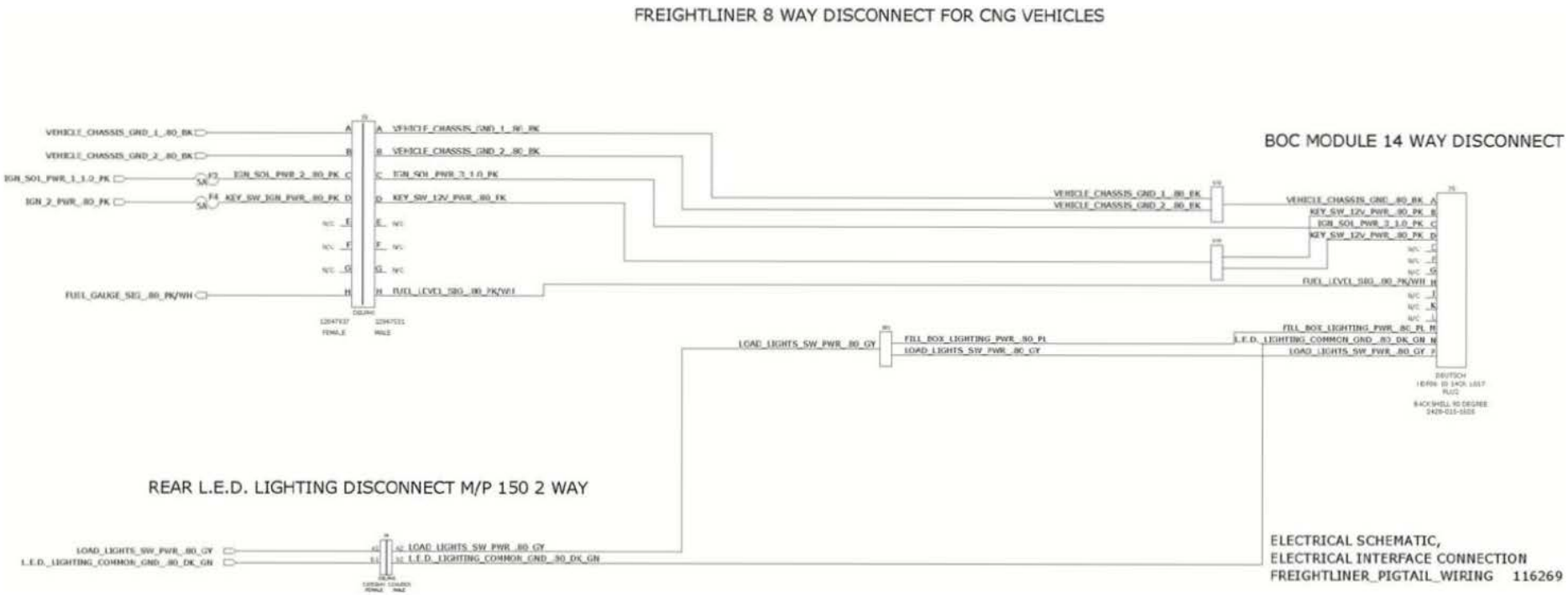


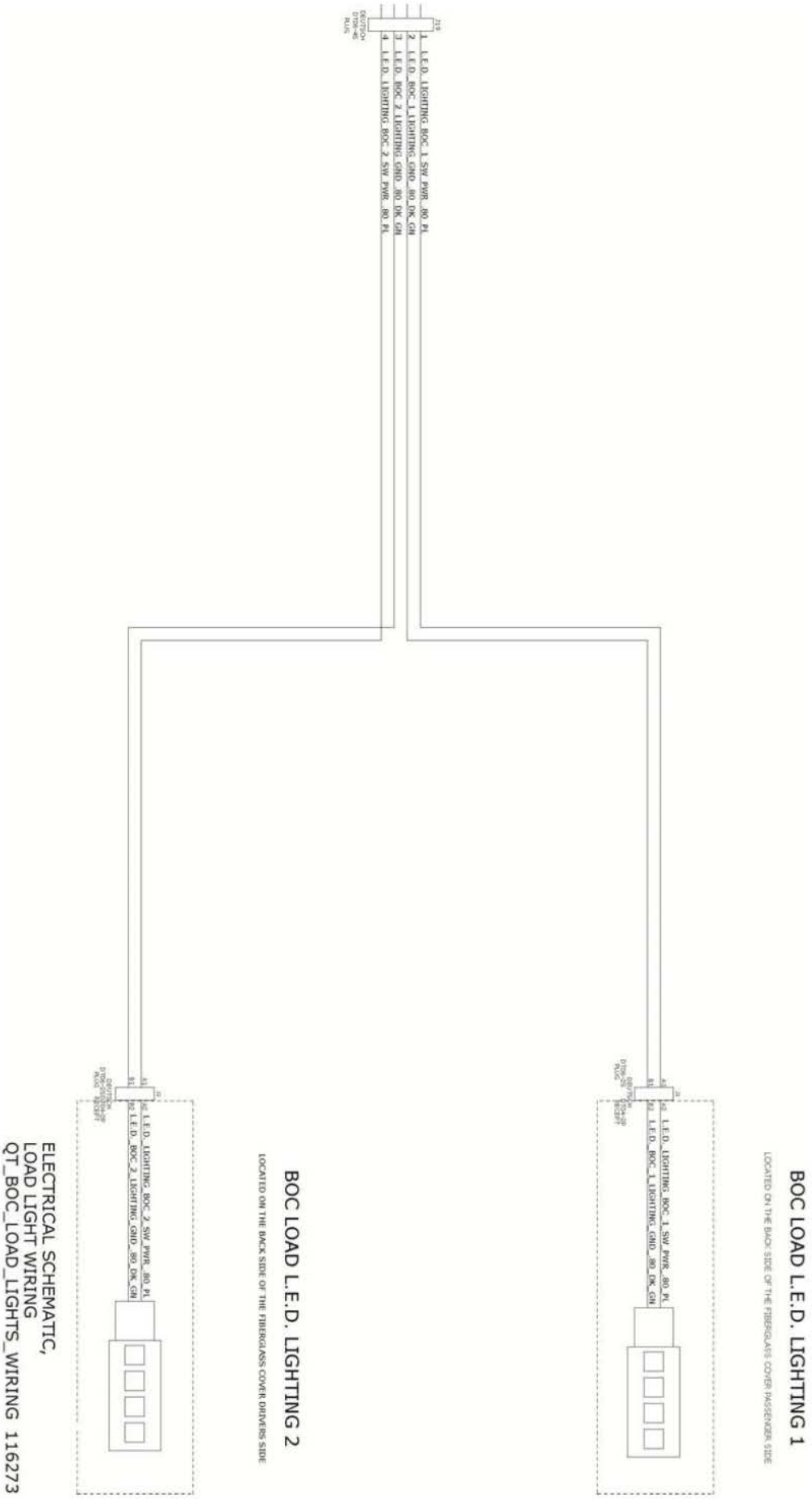
Appendix C – Wiring Diagrams

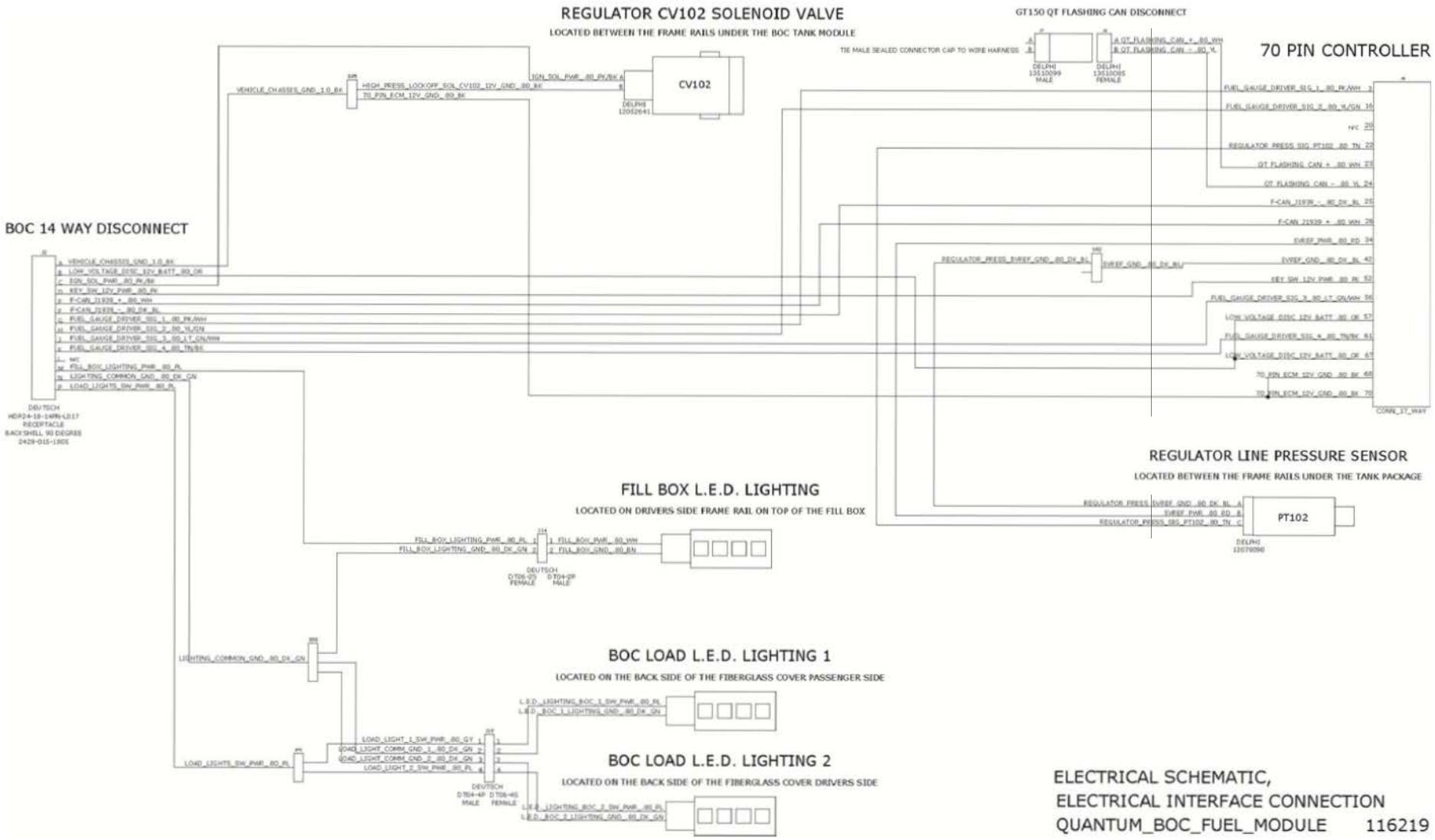



PACCAR 8 WAY DISCONNECT FOR CNG VEHICLES
VEHICLE_CHASSIS_NODE_GND_1.0_BK
LOW_VOLTAGE_DISC_12V_BATT_1_.80_OR
IGN_SOL_PWR_1_1.0_PK
IGN_2_PWR_.80_PK
TEMP_WARN_SIG/CAPS_OFF_.80_WH
FUEL_GAUGE_SENDER_SIG_.80_PK/WH
F3 5A
F4 5A
IGN_SOL_PWR_2_.80_PK
KEY_SW_IGN_PWR_.80_PK
A VEHICLE_CHASSIS_GND_2_1.0_BK
B LOW_VOLTAGE_DISC_12V_BATT_2_.80_OR
C IGN_SOL_PWR_3_1.0_PK
D KEY_SW_12V_PWR_.80_PK
E N/C
F F-CAN_J1939_+_.80_WH
G F-CAN_J1939_-_.80_DK_BL
H FUEL_LEVEL_SIG_.80_PK/WH
DELPHI
12047937 FEMALE
12047931 MALE
BOC MODULE 14 WAY DISCONNECT
VEHICLE_CHASSIS_GND_2_1.0_BK A
LOW_VOLTAGE_DISC_12V_BATT_2_.80_OR B
IGN_SOL_PWR_3_1.0_PK C
KEY_SW_12V_PWR_.80_PK D
F-CAN_J1939_+_.80_WH E
F-CAN_J1939_-_.80_DK_BL F
FUEL_LEVEL_SIG_.80_PK/WH G
N/C H
N/C J
N/C K
N/C L
FBL_PANEL_L.E.D._SW_PWR_2_.80_PL M
L.E.D._LIGHTING_COMMON_GND_2_.80_DK_GN N
LOAD_L.E.D._SW_PWR_2_.80_GY P
DEUTSCH
HDP26-18-14SN-L017
PLUG
BACKSHELL 90 DEGREE
2428-015-1805
REAR L.E.D. LIGHTING DISCONNECT M/P 150 4 WAY
FBL_PANEL_L.E.D._SW_PWR_1_.80_PL
L.E.D._LIGHTING_COMMON_GND_1_.80_DK_GN
LOAD_L.E.D._SW_PWR_1_.80_GY
N/C
FBL_PANEL_L.E.D._SW_PWR_2_.80_PL
L.E.D._LIGHTING_COMMON_GND_2_.80_DK_GN
LOAD_L.E.D._SW_PWR_2_.80_GY
N/C
DELPHI
12162144 FEMALE
12162102 MALE
ELECTRICAL SCHEMATIC,
ELECTRICAL INTERFACE CONNECTION
PACCAR_PIGTAIL_WIRING 116224


VOLVO 8 WAY DISCONNECT FOR CNG VEHICLES
VEHICLE_CHASSIS_GND_1_.80_BK
VEHICLE_CHASSIS_GND_2_.00_BK
IGN_SOL_PWR_1_1.0_PK
IGN_2_PWR_.80_PK
INSTRUMENT_GND_.80_DK_BL
FUEL_GAUGE_SIG_.80_PK/WH
IGN_SOL_PWR_2_.80_PK
KEY_SW_IGN_PWR_.80_PK
VEHICLE_CHASSIS_GND_3_.80_BK
VEHICLE_CHASSIS_GND_2_.80_BK
IGN_SOL_PWR_3_1.0_PK
KEY_SW_12V_PWR_.80_PK
FUEL_LEVEL_SIG_.80_PK/WH
255 OHM RESISTOR
BOC MODULE 14 WAY DISCONNECT
KEY_SW_12V_PWR_.80_PK
FUEL_LEVEL_SIG_.80_PK/WH
FULL_BOX_LIGHTING_PWR_.80_FL
LOAD_LIGHTS_SW_PWR_.80_GY
L.E.D._LIGHTING_COMMON_GND_.80_DK_GN
DEUTSCH
HDP26 18 14SN L017
PLUG
BACKSHELL 90 DEGREE
2428-015-1805
REAR L.E.D. LIGHTING DISCONNECT M/P 150 2 WAY
ELECTRICAL SCHEMATIC,
ELECTRICAL INTERFACE CONNECTION
VOLVO_PIGTAIL_WIRING 116227


FREIGHTLINER 8 WAY DISCONNECT FOR CNG VEHICLES
BOC MODULE 14 WAY DISCONNECT
REAR L.E.D. LIGHTING DISCONNECT M/P 150 2 WAY
VEHICLE_CHASSIS_GND_1_.80_BK
VEHICLE_CHASSIS_GND_2_.80_BK
IGN_SOL_PWR_1_1.0_PK
IGN_2_PWR_.80_PK
FUEL_GAUGE_SIG_.80_PK/WH
KEY_SW_IGN_PWR_.80_PK
KEY_SW_12V_PWR_.80_PK
FUEL_LEVEL_SIG_.80_PK/WH
LOAD_LIGHTS_SW_PWR_.80_GY
FILL_BOX_LIGHTING_PWR_.80_PL
L.E.D._LIGHTING_COMMON_GND_.80_DK_GN
ELECTRICAL SCHEMATIC,
ELECTRICAL INTERFACE CONNECTION
FREIGHTLINER_PIGTAIL_WIRING 116269


1 L.E.D. LIGHTING BOC 1 SW PWR 80 PL
2 L.E.D. BOC 1 LIGHTING GND 80 DK GN
3 L.E.D. BOC 2 LIGHTING GND 80 DK GN
4 L.E.D. LIGHTING BOC 2 SW PWR 80 PL
L.E.D. LIGHTING BOC 1 SW PWR 80 PL
L.E.D. BOC 1 LIGHTING GND 80 DK GN
L.E.D. LIGHTING BOC 2 SW PWR 80 PL
L.E.D. BOC 2 LIGHTING GND 80 DK GN
BOC LOAD L.E.D. LIGHTING 1
LOCATED ON THE BACK SIDE OF THE FIBERGLASS COVER PASSENGER SIDE
BOC LOAD L.E.D. LIGHTING 2
LOCATED ON THE BACK SIDE OF THE FIBERGLASS COVER DRIVERS SIDE
ELECTRICAL SCHEMATIC,
LOAD LIGHT WIRING
QT_BOC_LOAD_LIGHTS_WIRING 116273


REGULATOR CV102 SOLENOID VALVE
LOCATED BETWEEN THE FRAME RAILS UNDER THE BOC TANK MODULE
CV102
GT150 QT FLASHING CAN DISCONNECT
70 PIN CONTROLLER
BOC 14 WAY DISCONNECT
REGULATOR LINE PRESSURE SENSOR
LOCATED BETWEEN THE FRAME RAILS UNDER THE TANK PACKAGE
PT102
FILL BOX L.E.D. LIGHTING
LOCATED ON DRIVERS SIDE FRAME RAIL ON TOP OF THE FILL BOX
BOC LOAD L.E.D. LIGHTING 1
LOCATED ON THE BACK SIDE OF THE FIBERGLASS COVER PASSENGER SIDE
BOC LOAD L.E.D. LIGHTING 2
LOCATED ON THE BACK SIDE OF THE FIBERGLASS COVER DRIVERS SIDE
ELECTRICAL SCHEMATIC,
ELECTRICAL INTERFACE CONNECTION
QUANTUM_BOC_FUEL_MODULE 116219

Appendix D – FSM Final Inspection Form

Quantum FSM Final Inspection

Date _____ Cylinder SN _____

Technician _____ Mileage _____

✓ = OK X = Needs Repair N = Not Applicable

- ☐ Inspect Completed FSM And Note Any Damage
- ☐ Verify Cylinder Strap Spring Installed Height Is Properly Adjusted
- ☐ Verify All Critical Fasteners Have Been Properly Tightened
- ☐ Verify Adequate FSM Clearance To Vehicle Components
- ☐ Verify Any Openings Or Gaps In The FSM Covers Will Not Allow Debris Intrusion
- ☐ Verify All Heat Sources Are A Minimum of 5” (127 mm) From the FSM
- ☐ Verify Any Heat Source Closer Than 8” (203mm) To The FSM Cylinders Have Been Shielded
- ☐ Verify Cylinder Inspection Label Has Been Completed And Installed
- ☐ Purge Fuel Storage Cylinders
- ☐ Fill and Leak Check the Fuel Storage Module

Comments:

_____

_____

_____

Notes:

Revision History

Revision X1 – Review Draft
Revision X2 – Preliminary Draft
Revision X3 – Artwork, content, and data updates.
Revision X4 – Torque updates, added illustrations, packing list added, shim updates, stub out pipe info updated, lifting point section updated, and drill info updated. Added initial fill, purge, leak check, and filling the FSM in low ambient temperatures.

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Quantum Technologies Worldwide, Inc.
25242 Arctic Ocean Drive
Lake Forest, CA 92630
Tel: (949) 930-3400 Fax: (949) 930-3401
www.qtww.com
info@qtww.com